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EVALUATION OF A MODIFIED ATMOSPHERE PACKAGING SYSTEM TO INCREASE FRESH FRUIT AND VEGETABLE SHELF LIFE FOR EXTENDED MILITARY SUPPLY CHAINS

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**U.S. Army Natick Soldier Research, Development and Engineering Center
Natick, Massachusetts 01760-5020**

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14. ABSTRACT This report documents the evaluation of a case level Modified Atmosphere Packaging System (MAPS) designed to extend product shelf life of military fresh fruit and vegetables (FF&V). Three key items – iceberg lettuce, romaine lettuce, and broccoli crowns – were tested in the Pacific Region Guam supply chain. Due to longer total distribution times and/or less frequent end customer deliveries, some military FF&V supply chains require “extra” product shelf life than that provided by standard commercial product pack and supply chain procedures. Examples include: resupply of Navy platforms at sea; United States to Pacific Region surface supply chains; and deployment supply chains (e.g. Afghanistan and Iraq). Evaluation goals were to evaluate the potential benefits of the case level MAPS in terms of “extra” product shelf life, higher product quality/freshness at consumption, and reduced supply chain product losses/discards as a function of product post harvest age. This report documents the test objectives and scope, data collection methods, and evaluation results, and provides conclusions and recommendations.						
15. SUBJECT TERMS						
FRUITS	SHIPBOARD	FOOD STORAGE	TRANSPORTATION	PERISHABLE CARGO		
COSTS	PACKAGING	FOOD SPOILAGE	QUALITY ASSURANCE	STORAGE CONTAINERS		
SPOIL	VEGETABLES	COST SAVINGS	FOOD PRESERVATION	MILITARY PERSONNEL		
SHIPPING	SHELF LIFE	NAVAL VESSELS	TEMPERATURE CONTROL	OVERSEAS		
STORAGE	CONTAINERS	MICROORGANISMS	REFRIGERATION SYSTEMS	CHAINS		
HANDLING	FRESH FOODS	STORAGE STABILITY	LOGISTICS MANAGEMENT	SUPPLIES		
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- Camp Covington Dining Facility, Naval Base Guam
- DLA Troop Support (on-site Guam representatives)
- Subsistence Prime Vendor (SPV) Quality Distributors (Guam)
- Army Veterinary Corps (on-site Guam)
- Raymond Express International (DLA Troop Support – Pacific logistics contractor, Irvine, CA)
- Sienna Produce (DLA Troop Support – Pacific source produce contractor, Irvine, CA)
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Executive Summary

A membrane technology specifically designed by Apio BreatheWay™ to extend shelf life of fresh fruit and vegetables (FF&V) was evaluated in the Defense Logistics Agency (DLA) Troop Support – Pacific California-to-Guam surface supply chain. This technology is a case level modified atmosphere packaging system (MAPS). The evaluation included three produce items – iceberg lettuce, romaine lettuce, and broccoli crowns. It was conducted by the Combat Feeding Directorate (CFD), Natick Soldier Research, Development and Engineering Center (NSRDEC) between June 2009 to September 2010.

Select produce items (such as those evaluated) shipped across some extended military supply chains require longer shelf life than that provided by standard supply chain practices supporting commercial customers. For these unique military supply chains, extra (or extended) shelf life is often required (or desired) to cover longer total end-to-end distribution time, to facilitate more cost-effective distribution options, and/or to cover longer time intervals between less frequent end customer deliveries (for various reasons). Three examples of military supply chains where extra product shelf life provides benefits include: Navy platforms resupplied at sea, United States (California) to Pacific region surface supply chains (destinations Korea, Guam, mainland Japan, and Okinawa), and extended deployment supply chains (e.g., Iraq and Afghanistan).

With standard commercial pack and regular atmosphere distribution at near-optimal 32°F-33°F supply chain temperatures, the average shelf life for each of these items is 21 days. With current DLA Troop Support – Pacific Guam supply chain procedures, these items at the Guam delivery destination point are about 22 days post-harvest, i.e., near the end or beyond their expected average 21-day shelf life. As surface resupply for the Guam supply chain is conducted weekly, the minimum required product shelf life is 29 days to ensure sufficient daily availability of serviceable product until receipt of the next shipment. This required shelf life is considerably longer than the average 21 days utilizing standard supply chain procedures. For these reasons, the impact of inadequate product shelf life for this particular supply chain includes: reduced product freshness/low product quality at point of consumption, increased supply chain product losses/discard rates, and reduced likelihood of daily product availability for supported military customers.

Prior testing with the Apio BreatheWay™ MAPS case level membrane technology was mostly conducted in a controlled laboratory environment. This testing demonstrated significant shelf life extension benefits for several key produce items to include a 35+ day shelf life for iceberg lettuce, romaine lettuce, and broccoli crowns. This extended shelf life is considerably higher than the average 21 days for standard commercial pack product (and regular atmosphere supply chain distribution practices).

The objective of the Guam supply chain MAPS test was to validate/confirm the potential shelf life extension benefits of the BreatheWay™ MAPS case level membrane indicated by the laboratory testing in an actual extended military FF&V supply chain while utilizing existing standard DLA Troop Support procurement and supply chain procedures and existing

procurement and logistics support contracts to source the actual test product and deliver it to the supported customers.

Key facts relative to the scope of the Guam MAPS test include:

- Three test items – iceberg lettuce, romaine lettuce, and broccoli crowns
- Three test groups:
 - Group C – Standard commercial pack, controlled atmosphere container service
 - Group R – Standard commercial pack, regular atmosphere container service
 - Group M – MAPS BreatheWay™ case liner, regular atmosphere container service
- Three test shipments with product cases to potentially support 12 data sets
- Actual number of data sets collected per test item – 32 to 34
- Data set product post-harvest ages ranging from 23 to 39 days

Relative to shelf life impacts of the Group M MAPS case liner, overall Guam test findings were:

- Iceberg Lettuce – no additional or extra Group M product shelf life benefits. Product freshness ratings and “Good-to-Serve” case yields were similar for all three test groups across all data set age groupings. Initial product quality/condition varied between shipments. There was some internal core browning, and the product decayed more rapidly than expected. This degradation likely resulted from a higher product respiration rate and reduced internal case liner O₂ levels to below the target level due to both the use of a lower quality product than the “hand-selected” product utilized in prior laboratory testing and greater than expected test case repackaging-induced product damage at the DLA Troop Supports contractor’s container build site in Irvine, California.
- Romaine Lettuce – Group M cases had “extra” shelf life as compared to Group C and Group R cases, but less than the expected 35+ days. For 30+ days post-harvest data sets, the Group M average product freshness ratings and “Good-to-Serve” case yields were significantly better than those for Group C and Group R cases, which were very similar. Initial product quality/condition varied between shipments
- Broccoli Crowns – Test results confirmed Group M product shelf life of 35+ days and extra shelf life as compared to Group C and Group R product cases. Across all data sets, the Group M product case consistently had the highest product freshness ratings and “Good-to-Serve” case yields, while the Group C case had intermediate readings and the Group R case clearly the lowest ratings.

While the Guam MAPS test results revealed “as tested” no extra Group M iceberg lettuce shelf life benefits, and some but less than expected Group M romaine lettuce shelf life benefits, test observations and lessons learned did provide important insight into necessary technology and operational modifications to improve the shelf life benefits of the MAPS case liner for both of these produce items. These changes include:

- Adjustments to the MAPS case liner membranes are needed to optimize the external-to-internal MAPS case liner O₂ permeability, or transmission rate to address the high respiration rate discussed in the iceberg lettuce finding above and improve the MAPS

case liner shelf life extension benefits. The quality and condition of the produce provided by the DLA Troop Support contract for the Guam test was lower than the “hand-selected” product utilized in prior controlled laboratory testing. This difference, coupled with greater Guam MAPS case repackaging induced product damage likely resulted in higher product respiration rates resulting and faster product decay due to lower than target internal case liner O₂ levels.

- MAPS case liner repackaging procedures need to be modified in order to make them more resource efficient, and most importantly to minimize or mitigate product handling and repackaging-induced product damage and stress.

Due to the multiple benefits of extra FF&V product shelf life in various military supply chains, further testing and evaluation of the MAPS case liner and other shelf life extension technologies in another FF&V supply chain is recommended. Prior to follow-on testing of the Group M MAPS case liner in an actual military supply chain (for the same or other produce items), the following tasks should be performed:

- Develop revised MAPS case liner repack procedures to make the process more efficient, minimize product handling, and reduce product damage as a result of repacking.
- Using the revised MAPS case repack procedures, conduct laboratory testing with multiple shipments of DLA Troop Support contract-sourced products to assess and determine the optimum MAPS case liner membrane permeability parameters needed to reduce the variability found between shipments of both lettuce products and to achieve maximum product shelf life.

EVALUATION OF A MODIFIED ATMOSPHERE PACKAGING SYSTEM TO INCREASE FRESH FRUIT AND VEGETABLE SHELF LIFE FOR EXTENDED MILITARY SUPPLY CHAINS

1.0 Introduction

Military fresh fruit and vegetable (FF&V) supply chains sometimes require longer product shelf life for some FF&V items than that provided by standard commercial supply chain practices for commercial customers. The extra shelf life is needed to cover longer end-to-end supply chain distribution times and/or less frequent end customer deliveries. Examples of military supply chains requiring extra shelf life for some produce items include: Navy platforms resupplied at sea, United States (California) to Pacific region surface supply chains (Korea, Guam, mainland Japan, and Okinawa), and extended deployment supply chains (e.g., Iraq and Afghanistan).

This report documents the results of an assessment of the Apio BreatheWay™ technology, a case level modified atmosphere packaging system (MAPS), designed to extend the shelf life of select FF&V items. The objective was to evaluate the potential benefits of the MAPS technology in an actual extended military FF&V supply chain while utilizing existing standard Defense Logistics Agency (DLA) Troop Support procurement and supply chain procedures and existing procurement and logistics support contracts to source and deliver actual products to the customers. The evaluation was conducted in the California-to-Guam surface supply chain and included three key FF&V items – iceberg lettuce, romaine lettuce, and broccoli. The work efforts were conducted under a Combat Feeding Directorate (CFD) field data collection project during the June 2009 to September 2010 time period.

The Guam MAPS evaluation was jointly planned and managed by the Natick Soldier Research, Development and Engineering Center (NSRDEC) and Headquarters (HQ) DLA Troop Support – Pacific. Other test partners included:

- Army Veterinary Corp (on-site Guam)
- DLA Troop Support – Pacific (on-site Guam representatives)
- Guam dining facility, Magellan Inn, Andersen Air Force Base
- Guam dining facility, Camp Covington, Naval Base Guam
- Subsistence Prime Vendor (SPV) Quality Distributors (Guam)
- Raymond Express International (DLA Troop Support – Pacific logistics contractor, Irvine, California)
- Sienna Produce (DLA Troop Support – Pacific source produce contractor, Irvine, California)
- Apio, Inc (BreatheWay™ technology developer)

1.1 Navy MAPS Project

The BreatheWay™ technology was selected for testing based on results and findings from a prior Navy MAPS project conducted between January 2005 and September 2009. The Navy project was conducted by the Systems Equipment and Engineering Team (SEET), CFD, NSRDEC with contractor support from Apio, Inc., Guadalupe, California, funded by the Office of Naval Research (ONR) under the Technology Insertion Program for Savings (TIPS). TIPS focuses on commercial technologies that can be quickly adopted and inserted into military systems to generate cost efficiencies and savings.

The SEET Navy project focused on the development of new and emerging alternative near-term packaging technologies and end-to-end supply chain solutions to extend the shelf life and improve the freshness and quality of key FF&V items for Navy platforms at sea. The Navy identified 13 specific items requiring extra shelf life based on adequacy of current standard pack product shelf life, historical shipboard product freshness, spoilage and/or daily availability issues, level of item demand, and importance of each produce item from a galley menu nutritional and crew member morale and expectation perspective. For the selected FF&V item, the project threshold goal was a minimum 25% shelf life extension as compared to current standard commercial pack product. Controlled laboratory testing under the Navy project demonstrated that the Apio BreatheWay™ technology provided shelf life extensions greater than the target minimum 25% for 9 of the 13 Navy selected items. These items were bananas, broccoli crowns, broccoli florets, cantaloupes, beefsteak tomatoes, red sweet bell peppers, honey dew melons, romaine lettuce, and iceberg lettuce. For these items, the demonstrated shelf life extensions were between 40% and 67%. The other four items - celery, grapes, strawberries, and cucumbers - failed to demonstrate a minimum 25% extension in product shelf life. For these items, the primary challenge was product molds and associated decay.

Figure 1 provides a visual comparison of control (top) and BreatheWay™ technology pack (bottom) bananas at storage intervals of 6 days, 9 days, and 12 days, from left to right.



Figure 1. Comparison of MAPS (Top) and Control Bananas (Bottom) at Days 6, 9, and 12

1.2 MAPS Technology

The Apio MAPS technology utilizes the respiration of the produce item to consume the oxygen (O₂) in a tightly hand-sealed case liner and replace it with carbon dioxide (CO₂), a by-product of normal aerobic respiration. The Apio MAPS case liner system consists of a case liner with an applied BreatheWay™ membrane (see applied membrane in top cases in Figure 1). The BreatheWay™ membrane is designed with selective permeability to O₂ and CO₂, which restricts the movement of these gases in and out of the sealed case liner. Over time, for each produce item, the MAPS case liner system generates and targets an optimum equilibrium internal atmosphere with the O₂ lower than that found in ambient air (20.9%) and the CO₂ concentration higher than that in ambient air (0.03%). The permeability rate of the BreatheWay™ membrane is calibrated for each produce item to target different optimal internal case liner atmospheres. With proper supply chain temperature controls, the benefits of MAPS technology include delay of senescence (ripening), reduced product respiration, and decreased ethylene production rates which together slow the rate of product deterioration and extend product shelf life.

The BreatheWay™ case liner system consists of a 1.5 mil case liner with the addition of the BreatheWay™ polymer membrane applied over a punched hole in the case liner. The membrane provides a high permeability (280,000 cm³/100 in² atmosphere per 24 h) via the membrane with a CO₂ to O₂ permeability ratio of 3.8. This permeability allows for the creation of optimal internal atmospheric conditions that are unattainable with other packaging solutions such as micro-perforation. The BreatheWay™ membrane modulates the oxygen and carbon dioxide levels entering and leaving the case liner package, resulting in an ideal internal liner atmosphere that slows product respiration which extends product shelf life and improves both freshness and quality. The BreatheWay™ membrane technology includes three key features that are not available together in any other MAPS currently available. First, the membrane has a very high gas permeability, which supports packaging of high-respiration products or large quantities of products. Traditional packaging materials are unable to accommodate such applications without the introduction of macro-perforations. Second, the membrane's permeability can be tailored to match specific O₂ and CO₂ transmission rates that allow for highly product-specific package atmospheric requirements. Third, the membrane's polymer technology acts as a fully-reversible temperature switch that facilitates higher gas transmission rates at warmer temperatures and lower transmission rates at lower temperatures to target just the optimal atmospheric gas mix as supply chain temperatures fluctuate during end-to-end supply chain distribution and storage.

1.3 Selection of the Guam FF&V Supply Chain

The DLA Troop Support – Pacific has four primary areas of responsibility: Guam, Korea, mainland Japan, and Okinawa. Based on the unique characteristics and requirements associated with each Pacific region supply chain, NSRDEC and DLA Troop Support – Pacific jointly decided that the Guam supply chain would be the best MAPS test supply chain. Two key factors favoring the Guam selection included the simpler supply chain for MAPS test data collection, and the larger number of MAPS-compatible items presented CONUS sourced by surface from the United States.

1.3.1 Discussion of Selection Factors

From port offload to final customer delivery, the Guam supply chain was simpler than the Korea, mainland Japan, or Okinawa supply chains. In Guam, after port offload, the ocean carrier (Matson) immediately delivered the still-sealed containers directly to SPV storage facilities on Naval Base Guam, where they were opened for initial Corp inspection and required Guam agricultural inspections prior to product release. Following release, all DLA Troop Support product was offloaded and moved into SPV storage facilities for subsequent distribution to supported customers. The product containers were then closed and the carrier then made two additional stops to offload the remaining product at two main DeCA commissaries. The Korea, mainland Japan, and Okinawa destination supply chains were more complex, as both involved an intermediate stop and product rework prior to SPV delivery. In these supply chains, after port and customs clearing, the FF&V containers were transported to an intermediate facility operated by Raymond Express International (REI), a DLA Troop Support – Pacific logistics contractor. At the REI facility, the containers were unloaded for required product agricultural inspections, potential treatment (e.g. fumigation), and case level rework to remove any poor quality/spoiled product prior to being reloaded and forwarded onto the Korea, mainland Japan, or Okinawa SPVs or DeCA Commissaries. As a result, a MAPS test in these supply chains would have been more complex due to the additional data collectors and test controls at the intermediate stop at the REI facilities.

The other key factor in selecting the Guam supply chain was the larger number of MAPS-compatible items presently sourced by surface container from the United States. to include iceberg lettuce, romaine lettuce, broccoli crowns, sweet peppers, tomatoes (two types), cantaloupes, and honey dew melons. This compares to only three MAPS-compatible items (iceberg lettuce, broccoli crowns, and honey dew melons) for the mainland Japan and Okinawa supply chain, and just iceberg lettuce for the Korea supply chain.

1.3.2 Characteristics and Requirements of Pacific Region Supply Chains

For FF&V resupply from the United States (California), each of the four DLA Troop Support – Pacific primary supply chains is supported by weekly scheduled commercial surface container and commercial air (FedEx) shipments. If required, additional commercial air shipments are inserted to fill specific shortfalls or short notice resupply for load-outs of Navy supported platforms.

For the weekly surface container shipments, the DLA Troop Support and Defense Commissary Agency (DeCA) customer orders for all four Pacific region destinations are consolidated into a single product order for delivery to the DLA Troop Support – Pacific contractor's cold storage facility in Irvine, California. At this location, the consolidated delivery is broken down and reconfigured into customer-specific pallet loads for each Pacific region (e.g., Guam – DLA Troop Support SPV, Naval Base Guam; Guam – DeCA Commissary, Andersen AFB; and Guam – DeCA Commissary, Naval Base Guam). For each Pacific region destination, the resulting DLA Troop Support and DeCA customer-specific pallet loads are comingled in a set of containers at different set target temperatures for ocean transport and final customer delivery. The actual mix of items in each container is determined based on item order quantities,

optimal storage temperatures, and compatibility issues between items (based on ethylene production/sensitivity, aromatics, or off-odors, etc.). For the weekly build and load-out of containers, product is normally scheduled for Tuesday to Thursday delivery to the contractor's Irvine, California facilities, and by exception on Friday if needed. For the Irvine, California container build, all items for the same target containers (e.g., 33°F vegetable containers - iceberg, romaine, broccoli, carrots, etc) are scheduled for same-day Irvine, California receipt to facilitate same-day container load-out and departure for intermediate controlled atmosphere gassing or directly to port.

For the Guam supply chain, the carrier's Port of Long Beach container cutoff receipt time is 5:00 PM Tuesday for the scheduled Wednesday morning port departure. For the Korea and mainland Japan supply chains, the carrier's port cutoff is 5:00 PM Saturday for the scheduled Monday port departure. Due to the required intermediate stop for controlled atmosphere container gassing, these containers are delivered to port the day after container load-out or between Wednesday and Saturday. As a result, all weekly Guam containers miss the 5:00 PM Tuesday cutoff for same-week (Wednesday) departure, resulting in a Port of Long Beach hold time of 5 to 7 days. Similarly, the port delivery of the Korea and mainland Japan containers result in a port hold time of 3 to 5 days.

For each of the four primary DLA Troop Support – Pacific regions, varying portions of the overall FF&V requirement are sourced from the United States by surface, by air, or from local market FF&V distributors. Factors impacting these sourcing decisions include: local market product availability and pricing, import/agricultural restriction, seasonal availability, item shelf life, etc.

For over-ocean transport, the DLA Troop Support and DeCA orders for both mainland Japan and Okinawa are consolidated into one set of containers for initial delivery to mainland Japan. After required customs clearing and agricultural inspections, the single load is separated into mainland Japan and Okinawa container loads for transport to the supporting supply chain's SPV. Containers routed to Okinawa require an additional 2-day barge trip.

For each primary destination, all DLA Troop Support products are delivered directly to DLA Troop Support SPV facilities for follow-on distribution to the supported customers. For DeCA commissaries, the Irvine, California configured commissary-specific pallet loads are delivered directly to each commissary.

Based on current DLA Troop Support FF&V surface supply chain procedures, product post-harvest age is a minimum 21-23 days at Guam delivery and 28-30 days at Korea or mainland Japan delivery. Due to the long transport times and in an effort to extend product shelf life, each supply chain exclusively utilizes premium CA container service with three exceptions: Korea potato container, Korea onion container, and mainland Japan/Okinawa onion container.

1.4 Down-Selection of FF&V Items for MAPS Test

For the Guam surface supply chain, DLA Troop Support-Pacific and DeCA utilized only premium CA container service. Based on overall order size, optimal item storage temperatures,

and item compatibility, each weekly Guam surface container shipment typically consisted of four mixed CA container loads to include: at 33°F mixed vegetables to include iceberg, romaine, broccoli, carrots, cabbage, etc; also at 33°F (separate container), assorted apples (high ethylene producers); at 40°F, citrus and melons; and at 45°F, potatoes, onions, tomatoes, sweet peppers, etc. In addition to the different target container temperatures, each container also had different target controlled atmospheres based on the quantity and mix of items.

The Apio Breatheway™ membrane was designed to interface with regular external atmospheres (not altered or controlled atmospheres). As the Guam supply chain utilized only controlled atmosphere container service, the Guam MAPs test required inserting one or more regular atmosphere (RA) containers for each MAPS test shipment. Due to the added cost of about \$8 thousand per container, the decision was made to insert one RA container at 33°F for each test shipment and to limit the MAPS supply chain test to three important dining facility FF&V items of iceberg lettuce, romaine lettuce, and broccoli for which 33°F is the optimum transport/storage temperature. The insertion of the 33°F RA containers for the MAPS test supports a direct comparison of the MAPS test data results for Group C, Group R, and Group M (MAPS) test product as all product cases for each test group moved through the supply chain at the same optimum 33°F-34°F.

2.0 Approach and Methodology

The California-to-Guam surface supply chain for the iceberg lettuce, romaine lettuce, and broccoli crown test items was utilized to collect the required data to quantify and directly compare three different test groups of FF&V product cases:

- Group M – BreatheWay™ MAPS pack, regular atmosphere (RA) container service
- Group C – Standard commercial pack, controlled atmosphere (CA) container service
- Group R – Standard commercial pack, regular atmosphere (RA) container service

The three different test groups were compared in terms of the following:

- Product freshness and quality at initial delivery and over time
- Net case yield at initial delivery and over time
- Product shelf life

While the extended Guam FF&V supply chain was utilized for the MAPS test, the supply chain itself was not the focus. This surface chain was selected solely to collect comparative data to evaluate the potential benefits of the Apio BreatheWay™ membrane technology to extend product shelf life and improve the quality and freshness of delivered FF&V items for all extended military FF&V supply chains.

2.1 Test Controls - Product Sourcing and Supply Chain Controls

As the objective of the MAPS test was to evaluate the potential benefits of the BreatheWay™ MAPS case liner technology in an actual military supply chain, the in-place DLA Troop Support – Pacific procedures and contracts were utilized to source DLA Troop Support product cases for each test shipment. As a result, the starting quality and condition of the test product was representative of that typically received for Guam surface container shipments, which include normal week-to-week variability due to environmental, seasonal growing, and other factors.

To limit the potential impact of external factors or variables on the collected MAPS test data between test shipments and between test group product cases for a shipment, sourcing goals for each of the test shipments included:

- Tuesday receipt in Irvine, California of Monday date-of-harvest/pack product cases.
- Shipment of all product cases for each test item from all three test groups from the same vendor and lot (to include for broccoli planned iced Group R/Group C cases and iceless Group M cases).

To further limit the potential impact of variations in product quality between received product cases, set procedures were utilized to allocate the received product cases to each of the three test groups. For iceberg and romaine lettuce, all 38 total cases for the three MAPS test groups were received as a single product lot. As the received product pallets were broken down,

each removed case was sequentially assigned to the three test groups in the following order: M, C, R, M, C, R, M, C, R, etc., until all test groups had the planned test case quantities.

For broccoli, the test plan included receipt of separate lots of pre-iced cases for Group R and C cases and iceless cases for the Group M cases. However, for Test Shipments 1 and 2, only Group C cases were delivered pre-iced, and the Group R and Group M cases were delivered as iceless cases. For Week 3, the Group C and Group R cases were delivered pre-iced and the Group M cases iceless as planned. As for iceberg and romaine, similar procedures were utilized to break down and sequentially allocate the received Week 1 and Week 2 iceless cases to test Groups R and M and to allocate the received pre-iced Week 3 cases to test Groups R and C.

Various post-Guam-delivery supply chain controls and procedures were also implemented. These included:

- All Group M product case liners other than those in each shipment required for Guam agricultural inspections remained closed (as sent) until opened at the partner dining facility just prior to scheduled data collection.
- Group C and Group R product cases were each subjected to standard Guam supply chain procedures relative to Army Veterinary Corp inspections or SPV case rework to remove any inferior or spoiled product prior to dining facility delivery. However, if product is removed from any Group C or Group R case due to spoilage/poor condition, there was no transfer of any product between any Group C and Group R product cases.
- At SPV, all Group R, Group C, and Group M product cases were near each other in the same refrigerated storage room (target temperature: 34°F-35°F) until selection for delivery to the partner dining facility the day prior to, or the day of, scheduled MAPS test data sets.
- At each partner dining facility, when time permitted, a single individual culled the product case for all three test groups for one test item (e.g. broccoli) to obtain the “Good-to-Serve” net case weights. When two individuals culled product cases for the same item, then they coordinated and agreed on culling standards prior to actual case culling.

2.1.1 Extra Apio Broccoli for Test Shipments 2 and 3

Prior to the MAPS test launch, there were concerns over whether or not DLA Troop Support – Pacific would be able to obtain pre-iced test Group R and Group C broccoli cases and iceless Group M broccoli cases from the same source vendor with the same date-of-pack/lot number and, if not, the potential impact of any differences on the collected test data. For all three test shipments, the DLA Troop Support sourced iceless and iced broccoli cases from two different vendors.

To offset this potential risk, Apio, as a fresh broccoli processor, offered to provide separate complete sets of broccoli test cases to include iceless Group M and pre-iced Group C and Group R broccoli cases from the same product lot from their facilities in Guadeloupe, California. NSRDEC and DLA Troop Support – Pacific both agreed, and the extra complete set

of Apio broccoli Group M, Group C, and Group R broccoli test cases was included in the Week 2 and Week 3 test container shipments.

2.2 Test Container Temperatures

Variations between actual and optimal product supply chain temperatures can significantly affect resulting product shelf life and quality. For iceberg lettuce, expected product shelf life is 21-28 days at the optimum post-harvest temperature of 32°F, but a significantly lower 14 days at 41°F. Romaine and broccoli exhibit similar reductions in expected shelf life at 41°F as compared to the optimum post-harvest temperature of 32°F.

For each Guam test shipment, the Group M and Group R cases were transported together in the inserted weekly RA container, and the Group C cases were transported in the supply chain's regular scheduled mixed vegetable CA container. The set target temperature for each container was 33°F. However, actual container temperatures can vary slightly from these set temperatures due to periodic defrost cycles and sometimes to a larger extent due to malfunction. To capture actual end-to-end supply chain temperatures for each MAPS test container, a Ryan strip temperature recorder was placed in two MAPS test product cases in Irvine, California.

2.3 Test Shipment Case Quantities

Table 1 provides the details relative to each MAPS test shipment. Each test shipment included 38 total cases of DLA Troop Support – Pacific sourced product for each test item (iceberg, romaine, and broccoli crowns). The 38 cases included 36 cases (12 cases for each test group) to support a potential 12 data sets per shipment, plus two extra Group M cases to cover potential opening for any required Guam agricultural inspection requirements. In addition to DLA Troop Support – Pacific product, the Weeks 2 and 3 test shipments included a separate complete test set of 38 cases of Apio broccoli crowns.

Table 1. MAPS Test Cases per Test Shipment

Test Item	Test Group / Product Pack Type / Container Service					
	Group M MAPS Case Liner Regular Air		Group C Standard Pack Controlled Air		Group R Standard Pack Regular Air	
	Container Temp	No. Cases	Container Temp	No. Cases	Container Temp	No. Cases
Iceberg Lettuce	33°F	14	33°F	12	33°F	12
Romaine Lettuce	33°F	14	33°F	12	33°F	12
Broccoli Crowns (iceless)	33°F	14	---	---	---	--
Broccoli Crowns (iced)*	---	---	33°F	12	33°F	12

*While the test plan included “iced” Group R cases, the Shipments 1 and 2 cases were “iceless”, and only the Shipment 3 cases were “iced” .

For the planned Guam data collection, each data set required one product case from each of the three test groups (M, C, and R). Based on the expected shelf life of 35+ days for Group M product, each test shipment included product cases to support 12 data sets out to a post-harvest

age of 43 days based on two data sets per week at each partner dining facility for up to three weeks post-Guam-delivery.

For the Guam MAPS test, all iceberg and romaine lettuce test group cases were iceless. From prior experience, DLA Troop Support – Pacific sourced iced broccoli cases for their weekly Pacific region container shipments as iced provided a higher quality, fresher, and crisper/firmer salad bar quality product at destination than iceless. As a result, the Guam MAPS test plan included iced broccoli cases for the Group C and Group R cases and iceless cases only for Group M. However, due to insufficient coordination, the test Group R cases for Test Shipments 1 and 2 were iceless rather than the planned iced product cases.

2.4 Test Data Collection at Irvine, California

MAPS test recordkeeping and data collection at the DLA Troop Support – Pacific’s contractor’s facility in Irvine prior to container load-out included:

- Case labeling to uniquely identify/track each test group case
- Recording gross weight of each test Group C and Group R case (except iced broccoli)
- Recording the gross weight of each Group M case after the MAPS repack
- Summary observation of product quality

2.5 Test Container Shipment Dates

The Guam surface supply chain is supported by a Wednesday morning port departure for which there is a 5:00 PM Tuesday receipt deadline. For the MAPS test shipments, the test plan included Tuesday receipt of all test Group M, R, and C product cases by contractor at Irvine, California; same-day MAPS case liner repack of the Group M cases; same-day Tuesday load-out of the RA container with the Group M and Group R test cases; and setting aside of the labeled palletized Group C cases for loading on Wednesday into the supply chain’s normally-scheduled weekly 33°F CA mixed vegetable container.

For Test Shipment 1, the load-out of the RA container was delayed from Tuesday to Wednesday because of rejection of the first shipment of romaine lettuce cases due to excessive wind damage/leaf breakage. After receipt of the replacement product cases on Wednesday, the RA and CA containers were both loaded out on the same day.

For each test shipment, Table 2 details the container load-out and planned and actual port departure dates for the RA and CA test containers.

Table 2. MAPS Test Container Load/Port Departure Dates

Test Week	Container Loading	Planned Port Departure	Actual Port Departure	
			RA Container–Groups M & R	CA Container–Group C
1	9/16	9/23	9/23	9/23
2	9/22-9/23	9/30	9/23	9/30
3	9/29-9/30	10/07	9/30	10/7

As ocean transport conditions can vary (e.g., smooth or rough seas due to storms) and potentially impact product condition, the test plan was that the RA and CA containers for each test shipment would be on the same container ship. However, this only occurred for Test Shipment 1 (likely due to the one-day delay in load-out and delivery of the Test Shipment 1 RA container to port). For Test Shipments 2 and 3, the RA and CA containers were on different container ships due to the port receipt of the RA containers prior to the Tuesday 5:00 PM cutoff time and resulting loading onto the next day's scheduled departure (rather than being held to the following Wednesday). As a result, for Test Shipments 2 and 3, the RA containers arrived one week ahead of schedule where each was held sealed until delivery/receipt of the associated CA container the following week.

2.6 Test Data Sets

For each MAPS test shipment, the first data set was collected on the day of Guam SPV delivery/receipt, a Wednesday. Subsequent data sets for each test shipment were collected two times per week (Thursday-Friday and Monday-Tuesday) at each of the two partner dining facilities (Magellan Inn at Andersen Air Force Base and Camp Covington at Naval Base Guam) for 17 days post-delivery. For data analysis, each data set was categorized into one of five post-harvest age groups as follows:

- Age Group 1 – Data sets collected the week of delivery at Guam on Wed-Fri, 23-25 days post-harvest
- Age Group 2 – Data sets collected the subsequent Mon-Tue, 28-29 days post-harvest
- Age Group 3 – Data sets collected the subsequent Wed-Fri, 30-32 days post-harvest
- Age Group 4 – Data sets collected the second Mon-Tue, 35-36 days post-harvest
- Age Group 5 – Data sets collected the third Wed-Fri, 37-39 days post-harvest

Table 3 summarizes the actual number of collected data sets by test shipment and age group for each MAPS test item. For the DLA Troop Support – Pacific product, there were 11, 12, and 12 total data sets by test shipment for each test item, to include two or three data sets for each age group per test shipment, and six to nine total data sets for each age group across all three DLA Troop Support – Pacific product test shipments.

Test Shipments 2 and 3 included Apio broccoli cases to support 12 data sets. However, due to partner dining facility time constraints, only seven and ten Apio broccoli data sets were collected for the two Apio product test shipments.

Table 3. Guam MAPS Test Data Sets by Test Shipment

Shipment	Data Sets by Shipment, Post-Harvest Age (Days), and Days of Week					
	1	2	3	4	5	Total
	23-25 Wed-Fri	28-29 Mon-Tue	30-32 Wed-Fri	35-36 Mon-Tue	37-39 Wed-Fri	Data Sets
DLA – Shipment #1	3	2	2	2	2	11
DLA – Shipment #2	3	2	3	2	2	12
DLA – Shipment #3	3	2	2	2	3	12
DLA – Total	9	6	7	6	7	35
Apio Broccoli – Shipment #2	1	2	1	2	1	7
Apio Broccoli – Shipment #3	1	2	0	2	5	10
Apio Broccoli – Total	2	4	1	4	6	17

2.7 Test Data Collection and Rating Process on Guam

For each test item, each Guam data set utilized one product case from each test group from the same test shipment. Data collection consisted of ratings based on a survey (Section 2.7.1) and weighing the cases and comparing the weights to the weights recorded in Irvine, California to determine “Good-to-Serve” case yields (Section 2.7.2).

2.7.1 Freshness Rating Survey

At the start of each data set, the three test group cases were opened, set next to each other and arranged/displayed for pictures to document external and internal product freshness and condition of each test group case at the time of data collection. After the photos were taken, each evaluator completed a survey to assess and compare the product freshness and quality of cases from the three test groups. The Freshness Rating Survey Form utilized to collect this data is provided in Appendix A. For every data set, each evaluator completed a separate Freshness Rating Survey Form for each test item (iceberg lettuce, romaine lettuce, and broccoli). The number of evaluators for each data set varied, but most often was either five or six.

2.7.1.1 Freshness Quality Ratings

In the first part of the Freshness Rating Survey, evaluators independently rated the freshness of the Group R, Group M, and Group C product cases in terms of five freshness rating factors as follows:

1. Overall freshness (a separate overall freshness rating, not a computed average of the four specific freshness factor ratings)
2. External appearance
3. Internal appearance
4. Smell/odor
5. Crispness/firmness/springback

To rate each of the five freshness factors, the survey scale utilized nine descriptive freshness levels mapped to a 9-point rating scale:

1. Extremely Poor
2. Very Poor
3. Moderately Poor
4. Slightly Poor
5. Neither Good nor Poor
6. Slightly Good
7. Moderately Good
8. Very Good
9. Extremely Good

Based on the 9-point scale, average test group freshness ratings were computed by test item (iceberg lettuce, romaine lettuce, broccoli) for each test data set. For each same-test-shipment and same-age-group data set, these ratings were then averaged to obtain by-test-shipment/by-age-group average freshness ratings. These by-test-shipment results were then averaged across the three test shipments to obtain average by-age-group and by-test-group freshness ratings across all three test shipments. Figure 2 depicts the collection of test group product freshness ratings for iceberg lettuce at the Magellan Dining Facility on Andersen AFB.



Figure 2. Collection of MAPS Test Group Product Freshness Ratings

2.7.1.2 Relative Freshness Comparisons

The second section of the Freshness Rating Survey included three questions for evaluators to compare the overall product freshness between two test group cases. The three test group comparisons were:

1. Overall freshness of Test Group C case compared to Test Group R case
2. Overall freshness of Test Group M case compared to Test Group R case
3. Overall freshness of Test Group C case compared to Test Group M case

The rating scale consisted of comparison levels: one test group “Much Better”, “Moderately Better”, or “Slightly Better”; than the other and both test groups the “Same”; and the other test group being “Slightly Better”, “Moderately Better”, or “Much Better”. Numerical ratings were assigned for each case in the comparison to develop relative between-test-group freshness metrics. Reversed ratings were also assigned to reflect the rationale that selection of a positive rating for one group implies selection of negative rating for the other. Table 4 presents the survey’s descriptive rating scale along with the associated numerical ratings for a comparison between a Group C case and a Group M case. As Table 4 shows, a selection of “Case C Much Better” resulted in an Case C relative freshness score of 3 (positive, better) and a Case M rating of -3 (negative, worse).

Table 4. Relative Freshness Rating Scale for Group C and Group M Case Comparison

Descriptive Rating	Mapped Numerical Rating Scale	
	Case C	Case M
Case C Much Better	3	-3
Case C Moderately Better	2	-2
Case C Slightly Better	1	1
Both the Same	0	0
Case M Slightly Better	-1	1
Case M Moderately Better	-2	2
Case M Much Better	-3	3

For each shipment, the same age group data set averages were in turn averaged to obtain a higher level by-test-shipment/by-age-group average relative overall freshness test group ratings for each of the three comparisons. These results were then averaged across the three test shipments to obtain a higher relative overall freshness rating by age group average over all three test shipments for each of the three comparisons.

2.7.2 “Good-to-Serve” Case Yields

After completion of the test group product freshness ratings, each test group case was “culled” to remove sub-standard product and obtain “Good-to-Serve” case product. For each test group, the recorded post-culling weight included the actual case, any case liner (Group M – MAPS liner, Groups C and R – other standard liner), and the culled “Good-to-Serve” product. For the iceberg lettuce and the romaine lettuce, the percentages were calculated based on the starting gross Irvine, California case weights (provided in Appendix B) and the Guam data set post-culling gross case weights with the culled “Good-to-Serve” product returned to the case. After subtracting an average case fiberboard and case liner weight (MAPS or other) from the starting and post-culling gross case weight, the adjusted post-culling Guam case weight was divided by the initial Irvine, California case weight to obtain the percentage of “Good-to-Serve” case yield. (The calculation process is described in detail in Appendix B.) This eliminated the potential impact of normal variations in actual starting case product weights. However, this same “Good-to-Serve” case yield metric was not feasible across all broccoli test groups due to the inability to obtain starting gross case plus product-only weights for the iced test group broccoli cases at Irvine, California receipt (Test Shipments 1 and 2 – Group C cases, Test Shipment 3 – Group C and Group R cases). Recording the weights of the iced broccoli cases at

Irvine, California receipt was of no value due to the varying amounts of ice in/on each case, of which most/all melted during transit. Therefore, the “Good-to-Serve” case metric for all broccoli test groups was solely in terms of post-culling product case weight.

2.8 External Factors Impacting Test Group Data/Results

While the MAPS test plan included multiple controls to limit the potential impact of external test factors, three identified external factors potentially impacted the collected data:

1. Initial product quality/condition
2. Repack of Group M Cases
3. Variations in MAPS test container temperatures

2.8.1 Initial Product Quality/Condition

Actual product quality/condition at harvest can and does vary for many different reasons. This variability can in turn significantly impact the product’s actual shelf life and resulting quality/condition as a function of post-harvest age. Table 5 summarizes the initial or starting product quality received at Irvine, California for each MAPS test shipment. Across all three test shipments, the quality/condition of the Week 1 iceberg and romaine lettuce was considered substandard or below that typically received while all other MAPS test product was considered representative and typical of that normally received.

Table 5. MAPS Test Shipments - Product Quality/Condition at Irvine, California Receipt

FF&V Test Item	Test Shipment		
	Shipment 1	Shipment 2	Shipment 3
Iceberg Lettuce	Inferior – Below Typical	Good – Typical	Good – Typical
Romaine Lettuce	Inferior – Below Typical	Good – Typical	Good – Typical
Broccoli Crowns	Good – Typical	Good – Typical	Good – Typical

The Week 1 iceberg cases had extra loose external wrapper leaves that had extensive breakage due to wind damage prior to harvest. The Week 1 romaine cases also had above-average leaf breakage for the same reason. Initial plans were to reject the Week 1 iceberg cases but they were accepted due to an inability to locate better quality replacements for next-day delivery. For Test Shipment 1, the first set of romaine was rejected and replaced with product from an alternate source vendor. The somewhat better replacement set was accepted even though it was still considered inferior to that normally received. For Shipments 2 and 3, the quality/condition of the received iceberg and romaine cases was similar and considered to be representative of that normally received. The iceberg heads tended to have the normal one to two loose wrapper leaves and minimal or no leaf breakage.

For the three DLA broccoli shipments, quality/condition of received product was similar for all three test shipments and representative of that normally received.

2.8.2 Repack of Group M Cases

Within the United States FF&V supply chain, there is limited need for the Apio BreatheWay™ case liner for extra shelf life for bulk pack products (e.g., 24 whole iceberg heads/case) due to short end-to-end supply chain distribution times and frequent deliveries. As a result, utilization of MAPS case liner for extended military FF&V supply chains will require the insertion of a case level MAPS repack operation at an appropriate supply chain node/location. For maximum shelf life extension, the case repack operation should be undertaken as soon as practical post-harvest.

For the Guam MAPS test, the MAPS Group M case repack was performed at the DLA Troop Support – Pacific produce contractor's cold storage facilities in Irvine, California. For all Pacific region supply chains, this is an ideal point as all product flows through it for container load-out to each Pacific region. In addition, fresh pick items should be only 1 to 2 days post-harvest when received at Irvine, California for same-day MAPS repack and container load-out.

Before starting the Group M case repack for Test Shipment 1, the Apio technical representative provided on-site employee training on proper MAPS case liner repack procedures and how to close/seal the MAPS case liner. Figure 3 depicts the initial MAPS Group M case liner repack training for romaine lettuce with head-by-head product transfer. The initial planned starting repack procedures for iceberg lettuce and broccoli crowns were similar.

In order to start the Test Shipment 1 repack process, all product was removed from the first case and set aside. The MAPS case liner was then inserted and properly positioned inside the empty case. Product from the second case was then directly transferred head-by-head into the first case with the MAPS case liner. After all case product was transferred and positioned inside the MAPS case liner, the liner was closed and secured. This process was repeated for each MAPS case and is illustrated in Figure 3.

After the initial MAPS repack training, the iceberg lettuce in Test Shipment 1 was the first test item that was repacked. After just five to six cases, it was evident that the head-by-head case repack process was time consuming and generated a lot of incremental damage/breakage to the external wrapper leaves. The damage was magnified due to large head size, extra loose wrapper leaves with extensive breakage at receipt, and required handling/pushing to fit/force each head back into a 3 x 4 x 2 case. Based on the repack workload and imparted product stress, the iceberg repack procedures were modified for Test Shipment 1 and again for Test Shipment 3.

The revised Test Shipment 1 iceberg case repack procedures involved the transfer of a full product case to an empty case with a MAPS liner. This revised repack procedure was utilized for all three MAPS test items. With this method, product was removed from the first case, and a MAPS case liner was positioned inside the empty case. Then the bottom case flaps of the full product case to be transferred were opened. The full product case with open bottom flaps was then lifted, inverted, and placed on top of the empty receiving case to slide/drop the contents of the top full case into the empty bottom case.



Figure 3. Romaine Lettuce MAPS Repack Training with Initial Head-by-Head Repack

Figures 4 and 5 depict the resulting revised Week 1 full case to empty case with MAPS liner repack procedures for iceberg lettuce and broccoli crowns. The revised Week 1 repack procedures for romaine lettuce were identical to those utilized for iceberg lettuce.



Figure 4. Romaine Case Repack – Full Case to Empty Case with Internal MAPS Liner

The revised Week 1 Group M case repack procedures were quite effective for most cases as all heads tended to transfer into the receiving case as a standard 4 x 3 x 2 case pack with little to no need to intervene to push/reorient the heads for proper case fit. However, for two or three cases, the product transfer was less effective and manual intervention was required to reorient the heads to facilitate proper MAPS case liner and case closure.

With romaine lettuce, the revised Test Shipment 1 case repack procedure was more effective than that for iceberg lettuce as there was little to no need to push or reorient any heads for proper case fit. This is likely attributable to the overlapping standard case pack for romaine heads which tended to hold the heads together as a single product block during case-to-case

transfer. With broccoli crowns, the full case to empty case product transfer was efficient but tended to result in overfull boxes and the need to shake the box or push/reorient some product to fit all product and close the case without excessive case bulging.



Figure 5. Broccoli Case MAPS Repack – Full Case to Empty Case with Internal MAPS Liner

For Test Shipment 2, the same full case to empty case product transfer was utilized for all Group M product cases. For Test Shipment 2, the iceberg case repack was less successful, with cases more often requiring additional effort to push/reorient the 24 heads into the case for fit and MAPS case liner closure. This was likely due to the test having larger/denser heads resulting in a tighter case fit as compared to Test Shipment 1. For the Test Shipment 1 and 2 iceberg lettuce full case product transfers, the open bottom case flaps of the top emptying case were inside the bottom receiving case. This positioning resulted in a slight product deflection during the transfer that hindered the bottom layer from dropping as a single block into the receiving case, and in turn the need to manually intervene to reorient the bottom layer heads back into proper position for proper case fit and closure. For the Test Shipment 2 Group M romaine lettuce and broccoli crowns, the effectiveness of the full case to empty case product transfer repack process was similar to that for Test Shipment 1.

For the Test Shipment 3 repack, the same procedures were utilized for all romaine lettuce and broccoli crowns with similar results. For the iceberg lettuce repack, after four cases, a third repack method was implemented to try to facilitate a more effective case-to-case transfer. The third repack method is depicted in Figure 6. With this method, the open top case flaps of the receiving case were tightly secured with a large rubber band outside the case in the down position. The full case with product to be transferred was then turned upside down and the bottom flaps were opened and tightly secured to the side of the case with two large rubber bands. The MAPS case liner was then slid over the outside of the full product case and securely held so that the case liner was snug with the product of the opened full case. The full case with the external MAPS case liner was then lifted, inverted, and placed over the empty case so that the MAPS case liner and product could slide/drop together into the receiving case. This case repack method was clearly the most effective, and all 24 heads typically transferred as a single block with minimal need to reorient any heads for proper fit and case closure.



Figure 6. Week 3 Iceberg MAPS Repack – Full Case with External Liner to Empty Case

2.8.3 Variations in MAPS Test Container Temperatures

The target temperature for each weekly MAPS test RA and CA container was 33°F-34°F, which is the optimal temperature for maximum product shelf life for each test item. As variations between optimal and actual product temperatures can significantly impact resulting product shelf life, two Ryan strip recorders were placed in separate cases in each MAPS test container to record actual container temperatures. In addition, copies of the ocean carrier's hourly container temperature logs were obtained for each container with MAPS test product.

A review of the Ryan strip recorders and carrier temperature logs showed that the Test Shipment 1 and 2 RA and CA containers and Test Shipment 3 CA container all maintained tight temperature controls near the target 33°F-34°F temperatures from container closure in Irvine, California to final SPV delivery and container opening in Guam. With the exception of the expected occasional short-term (1 to 2 h) slight temperature elevations associated with refrigeration unit defrost cycles, each of these containers maintained very tight temperatures near the target 33°F-34°F set temperature. However, a review of the strip recorders and carrier hourly temperature logs for the Test Shipment 3 RA container (with Group M and Group R product

cases) revealed that it only maintained effective temperature controls for the first 15 total days and that for the final 7 days the container temperatures were significantly elevated, in the 42°F-52°F temperature range. This container arrived in Guam 1 week ahead of schedule, where it was off-loaded and held closed/sealed as delivered for 7 days prior to actual opening. The 7 days of significantly elevated temperatures for the Test Shipment 3 RA container very likely negatively impacted the shelf life and freshness of Test Shipment 3 Group M and Group R product cases relative to that for Group C product cases.

3.0 Observations, Results, and Discussions

For each test item, results are separated by external test factors, general observations, test group freshness and relative freshness ratings, and test group “Good-to-Serve” case yields.

3.1 Iceberg Lettuce

3.1.1 External MAPS Test Factors

Table 6 details identified external test factors discussed in Chapter 2 that potentially impacted the collected Guam MAPS test group data by test shipment or between test shipments. Key points include:

- Product quality/condition of Test Shipment 1 cases received at Irvine, California was substandard and inferior as compared to Test Shipments 2 and 3.
- Group M case liner repack imparted stresses that were the highest for Test Shipment 1, intermediate for Test Shipment 2, and the least for Test Shipment 3.
- Group R and Group M product cases for Test Shipment 3 were adversely impacted due to 7 days of continuous elevated container temperatures (40°F-50°F) above the target 33°F-34°F temperature.

Table 6. Iceberg Lettuce – External MAPS Test Factors

External Factor	Test Group	Week 1	Week 2	Week 3
Initial Quality at Irvine, California receipt	All Groups (C, R, M)	Poor – Substandard Extensive leaf breakage	Good – Typical Minimal leaf breakage	Good – Typical Minimal leaf breakage
MAPS Repack Product Stresses	Group M	Highest	Intermediate	Lowest
Container Temperature Controls	Group C	Excellent (32°F-34°F)	Excellent (32°F-34°F)	Excellent (32°F-34°F)
	Group R	Excellent (32°F-34°F)	Excellent (32°F-34°F)	Poor Last 7 Days (40°F-50°F)
	Group M	Excellent (32°F-34°F)	Excellent (32°F-34°F)	Poor Last 7 Days (40°F-50°F)

3.1.2 General Guam Observations of Quality/Condition

Table 7 summarizes general observations made by the evaluators relative to test group product quality/condition across the Guam data collection sets. These represent general observations only and are not based on subsequent reduction/analysis of the collected data.

Table 7. Iceberg Lettuce–General Guam Observations

Factor	Test Shipment	Test Group	Observation
Freshness/ Quality at Guam Receipt*	1	All	Each Test Group – Similar product quality/freshness. Lower quality/freshness than for Test Shipments 2 and 3 (due to excessive pre-harvest wind damage/leaf breakage).
	2-3	All	Each Test Group – Similar quality/condition both shipments. Better product quality/condition than for Test Shipment 1.
Freshness/ Quality 7-10+ Days Post-Guam Receipt	1	All	Each Test Group – Product decayed faster than for Shipments 2 & 3. Each Test Group – Major product decay/with case leakage/drippage. Groups R and C – Some cases 100% loss at 35 days post-harvest.
	2-3	All	Each Test Group – Degraded slower than Test Shipment 1. No observed case leakage.
Internal Core Browning	1-3	M	Group M – More frequent/severe internal core browning than for same-shipment Group R or C cases. Magnitude of Group M core browning increased with product post-harvest age.

*At Guam receipt product was 23+ days post-harvest.

By test shipment, all three iceberg lettuce test groups exhibited similar product quality/freshness at initial Guam receipt (23-25 days post-harvest). The quality/condition of the Shipment 1 product was clearly lower than that for Shipments 2 and 3. The Shipment 1 product for all test groups degraded faster than the Shipments 2 and 3 product. Shipment 1 product at 7 to 10 days post-Guam-delivery exhibited significant product decay/rot and product leakage for all three test groups, with 100% product spoilage for some cases. For Test Shipments 2 and 3, observed product decay at 7 to 10 days post-delivery (30+ days post-harvest) was much lower with no observed product leakage. This was expected because the quality/condition of the Shipment 1 product received at Irvine, California, was relatively poor compared to Shipments 2 and 3 product received at Irvine.

As noted in Table 7, in all three shipments, Group M case product contained internal core browning of some heads. This was unexpected, as it was not observed in the Navy MAPS testing. While this same condition was also observed with some Group R and Group C product cases, it was clearly more frequent and severe in the Group M product. At or near initial delivery, the observed internal core browning, to include differences between test groups, was minimal. Figure 7 depicts the internal core browning for Shipment 2 Group M product at 24 days post-harvest (top) and at 31 days post-harvest (bottom). The extent and severity of the Group M internal core browning appeared to increase with product age, and it was clearly more prevalent and severe in Group M than in the other groups. After review of Irvine and Guam product photos and MAPS case liner repack procedures, Apio technical experts concluded the likely cause of the internal core browning was a combination of less robust/more stressed initial product and higher MAPS case repack-imparted stresses than in the Navy tests. These factors resulted in an increased product respiration rate and drawdown of the internal MAPS O₂ level below the targeted level, which caused the observed browning and faster-than-expected Group M product decay. Apio indicated that, if this was the cause, it can be corrected with an adjustment to the BreatheWay™ membrane to facilitate a higher external-to-internal case liner O₂ transfer rate.



Figure 7. Group M Iceberg Lettuce Internal Core Browning. Top: 24 Days Post-Harvest; Bottom: 31 Days Post-Harvest

3.1.3 Test Group Freshness Rating Results

This section contains results indicated for the five freshness rating factors in the first part of the Freshness Rating Survey Form (provided in Appendix A) using the 9-point quality scale, as discussed in Section 2.7.1.1. The results for the overall freshness factor are discussed in detail in Section 3.1.3.1. The results of the other four factors (external appearance, internal appearance, smell/odor, and crispness/firmness/springback) are briefly summarized in the following subsections and are detailed in Appendix C.

3.1.3.1 Overall Freshness

At the start of each data collection set, the three product cases were opened and the product displayed for photos to document the quality/condition of the product for each test group case. Photos included one with the three test group cases side-by-side with the Group M case in the middle for direct visual comparison. Separate close-up photos of each test group case were also taken.

Figures 8 to 10 provide the photos for three iceberg data sets at different post-harvest ages. Figure 8 shows products from Test Shipment 1 at 28 days post-harvest (Covington Data Set 1-2). Figures 9 and 10 show products from Test Shipment 2 at 22 and 36 days post-harvest (SPV Data Set 2-1 and Covington Data Set 2-4), respectively.

Note the extra and more damaged wrapper leaves in the Test Shipment 1 product (Figure 8) as compared to Test Shipment 2 product (Figure 9). While not depicted, Test Shipment 3 product cases were similar to the Test Shipment 2 cases. At 22 days post-harvest, Figure 9 depicts similar product quality for all three test groups with no noticeable product decay. This was expected based on the expected 21+ day shelf life for Group R cases and longer expected shelf life for Groups M and C. In comparison, Figure 9 depicts some product decay, but still quite similar product quality for all three test groups at 36 days post-harvest. Expectations at 36 days post-harvest were that the Group M and Group C iceberg cases would exhibit higher product quality and freshness than the Group R cases. However, Guam data observations and subsequent analysis failed to confirm this expectation and instead revealed similar results for all three test groups up to 35 days post-harvest and only slightly better Group M product freshness for the 35+ day post-harvest data.



**Figure 8. Iceberg Lettuce – Shipment 1, 28 Days Post-Harvest (Covington Data Set 1-2).
Left: Group R; Center: Group M; Right: Group C**



**Figure 9. Iceberg Lettuce – Shipment 2, 22 Days Post-Harvest (SPV Data Set 2-1).
Left: Group R; Center: Group M; Right: Group C**



**Figure 10. Iceberg Lettuce – Shipment 2, 36 Days Post-Harvest (Covington Data Set 2-4).
Left: Group R; Center: Group M; Right: Group C**

Figure 11 displays the resulting average overall freshness ratings (based on the 9-point scale) across the 34 Guam iceberg lettuce data sets. The supporting detailed data tables are provided in Appendix C, along with similar charts and associated data tables for the other four rated freshness factors. In Figure 11, the top chart depicts the average ratings by data set, the middle chart average ratings by test shipment and data set age group, and the bottom chart average ratings across all three test shipments by-age-group averages. In the middle chart, the average ratings by test shipment are intentionally offset and in the following order (left to right): Week 1, Week 2, Week 3.

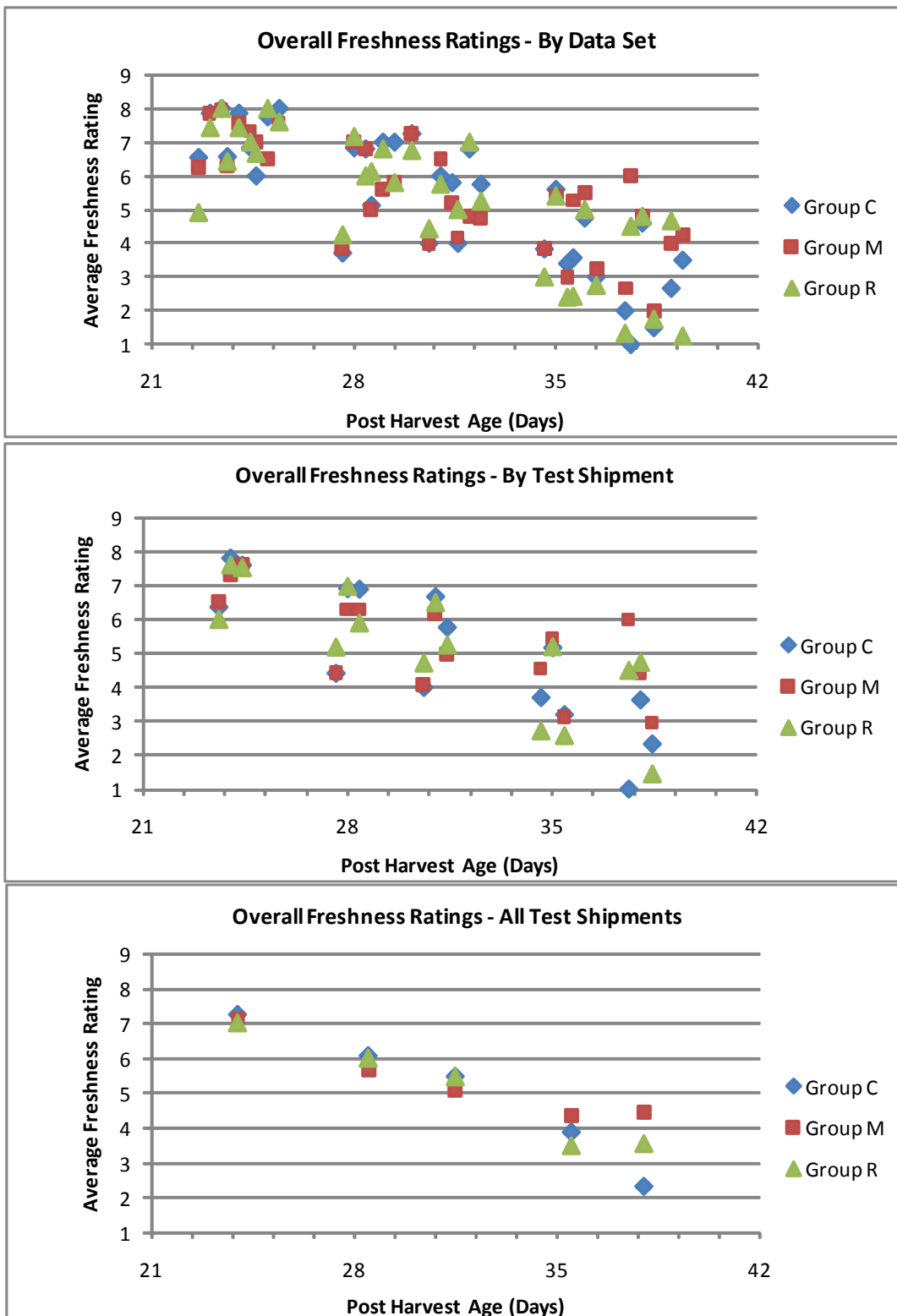


Figure 11. Iceberg Lettuce – Overall Freshness Ratings by Test Group. Top: By Data Set; Middle: By Test Shipment; Bottom: All Test Shipments Combined

As Figure 11 shows, average by-test-group overall freshness ratings were quite similar for each test group for the 23-25 day post-harvest data sets. For each test group, the average overall freshness rating (bottom chart) was similar and near 7 (“Moderately Good”) for all 23-25 day post-harvest data sets and slightly above 5 (“Neither Good nor Bad”) for all 30-32 day post-harvest data sets. For all 35+ day post-harvest data sets, the average overall freshness rating for all test groups was below 5 (“Neither Good nor Bad”) while the average Group M overall freshness rating was somewhat better. For the twelve 35+ day post-harvest data sets, the average overall test group freshness ratings were Group M – 4.42, Group R – 3.53, and Group C – 3.10.

3.1.3.2 External Freshness

For the 23-25 day post-harvest data sets, average external freshness ratings by test shipment were similar for all test groups, with Test Shipment 1 ratings lower than those for Test Shipments 2 and 3. For these data sets, average by-test-group ratings were between 5 and 6 (“Neither Good nor Bad” to “Slightly Good”) for Test Shipment 1 and near 7 (“Moderately Good”) for Test Shipments 2 and 3. The lower Test Shipment 1 ratings are attributed to the excessive pre-harvest breakage of the external wrapper leaves due to wind damage (which did not occur in Test Shipments 2 and 3 product) prior to delivery at Irvine, California.

For similar post-harvest age data sets, there was considerable variability in the average by-test-group external freshness ratings even for same-test-shipment data sets. However, for each data set age group, the resulting average test group external freshness ratings were quite similar up to the 30-32 day post-harvest data set age group, with some separation in test group ratings and slightly higher Group M ratings only showing up in the 35+ day post-harvest data sets.

For the 30-32 post-harvest age group data sets, the average external freshness ratings for each test group dropped below 5, between “Neither Good nor Poor” and “Slightly Poor”.

3.1.3.3 Internal Freshness

At 23-25 days post-harvest, by test shipment the average internal freshness ratings were also similar for all three test groups with Test Shipment 1 ratings lower than for Test Shipments 2 and 3. For all 23-25 day post-harvest data sets, the average test group ratings were 6.5 (between “Slightly Good” and “Moderately Good”) for Test Shipment 1, and about 7.4 (between “Moderately Good” and “Very Good”) for Test Shipments 2 and 3. The lower Test Shipment 1 freshness ratings extended out to the 30-32 day post-harvest age data set age grouping.

For similar post-harvest age data sets, there was considerable variability in the by-test-group average internal freshness ratings between test shipments and also between same shipment data sets. For the 28-29 and all 30-32 day age group data sets, the average internal freshness ratings for Group M case product was lower than for the Group C and Group R cases. Across all 30-32 day post-harvest data sets, the average Group M rating at 4.45 was below 5 (“Neither Good nor Bad”) while the average ratings for Groups C and Group R cases were more than a point higher at 5.64 and 5.58 respectively. The lower Group M internal freshness ratings are likely attributable to the more frequent and severe internal core browning discussed in Section 3.1.2.

3.1.3.4 Smell/Odor

At 23-25 days post-harvest, the by-test-shipment average data set smell/odor freshness ratings were similar for each test group, with Shipment 1 ratings lower than for Shipments 2 and 3. For these data sets, the average ratings were about 6.1 (somewhat above “Slightly Good”) for Shipment 1 and about 7.4 (between “Moderately Good” and “Very Good”) for Shipments 2 and 3. The lower Shipment 1 average freshness ratings which extended out to the 30-32 day post-harvest data set age group are attributed to the extensive pre-harvest breakage to external product wrapper leaves at Irvine, California receipt which resulted in more significant product decay.

There was also considerable variability in the by-test-group average internal freshness ratings between same-shipment data sets and between test shipments. For the 23-25, 28-29 and 30-32 day post-harvest data set age groups, the average smell/odor freshness ratings were similar for each test group. They were near 7 (“Moderately Good”) for the 23-25 day age group and declined to slightly above 5 (“Neither Good nor Bad”) for the 30-32 day data set age group. For the combined 35-36 and 37-39 data set age groups, the average Group M smell/odor freshness ratings were 4.5 (between “Neither Good nor Bad” and “Slightly Bad”), 0.7 to 1.3 points higher than the average ratings for the Group R and C cases.

3.1.3.5 Crispness/Firmness/Springback

For the 23-25 day post-harvest data set age group, the by-test-shipment product crispness ratings were again quite similar for each test group and somewhat lower for Test Shipment 1 than for Test Shipments 2 and 3. For this age group and Test Shipment 1, the by-test-group average freshness ratings were each between 6 (“Slightly Good”) and 7 (“Moderately Good”), while for Test Shipments 2 and 3 they were all higher and very similar, in the 7.6 to 7.8 range.

For similar post-harvest age data sets, there was considerable variability in the average crispness/firmness ratings between test shipments and also for same test shipment data sets. However, for all data sets in the 23-25, 28-29, and 30-32 day age groups, the average crispness/firmness ratings for all test groups were similar. They were slightly above 7 (“Moderately Good”) for the 23-25 day age group, between 6 and 7 (“Slightly Good” to “Moderately Good”) for the 28-29 day age group, and slightly below 6 (“Slightly Good”) for the 30-32 day age group. For the 35+ day age groups, the Group M average crispness/firmness ratings were somewhat higher than the Group C and Group R ratings. For the two 35+ day data set age groupings, the average crispness/firmness rating for the Group M cases at 5.23 remained positive, above 5 (“Neither Good nor Poor”), while the average ratings for Group C and Group R cases, declined to 3.89 and 4.30 respectively.

3.1.4 Results of Overall Relative Freshness Rating Comparison of Test Groups

This section contains results indicated for the group-to-group case comparisons (M to C, M to R, and C to R) in the second part of the Freshness Rating Survey (provided in Appendix A) that used rating levels and corresponding positive and negative numerical values to compare and rate the relative overall product freshness between two test groups, as discussed in Section

2.7.1.2

Figure 12 depicts the results for these comparisons for all three test shipments combined by data set age group. The supporting detailed data tables are provided in Appendix D. In Figure 12, the table headings of a test group letter with a +, ++, or +++ reflect the designated test group letter being selected and rated as “Slightly Better”, “Moderately Better”, or “Much Better” relative to the comparison test group. The percentage of raters who selected each rating level was first computed for each data set, and each data set was aligned into one of the defined age groups. The percentage of raters selecting each rating level was then averaged across all within-age-group data sets to compute the percentages and bar charts depicted in Figure 12. As the charts show, there was considerable variation in the by-data-set relative freshness comparisons between test groups for all age groupings and no clear evidence that the relative freshness of product cases for any one test group was better than the others. The wide variations are associated with observed variations in product freshness and quality. For example, a Magellan data set Group M case may have had a better rating than the Group C case, while the next-day Covington data set Group C case may have had a higher rating than the Group M case.

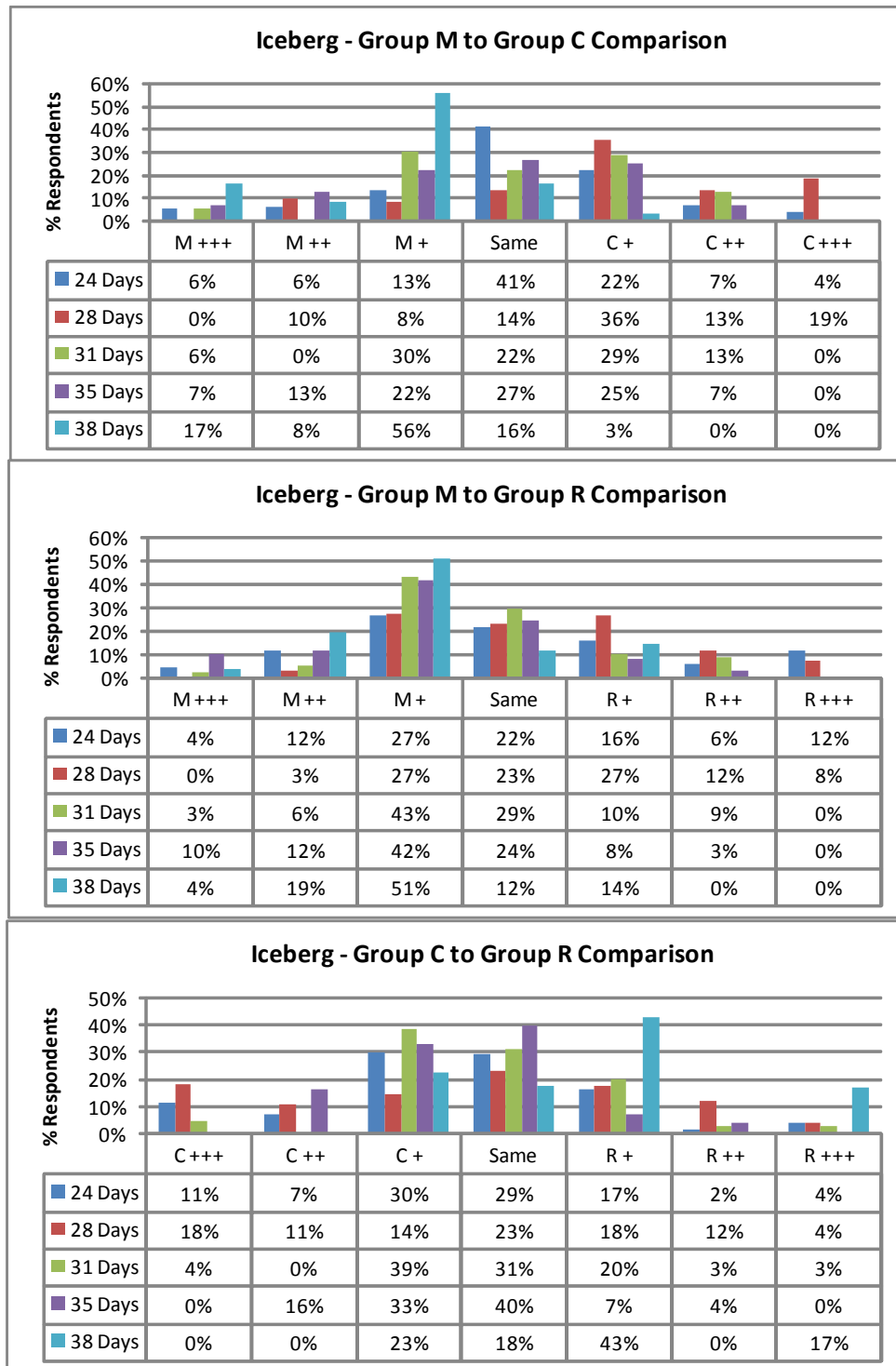


Figure 12. Iceberg Lettuce – Comparison of Overall Freshness between Test Groups. Top: Group M to Group C; Middle: Group M to Group R; Bottom: Group C to Group R

Figure 13 depicts the average Group M relative freshness rating compared to Group R and Group C for all data sets within an age grouping. The supporting detailed data tables are

provided in Appendix D. Figure 13 was generated by first converting the relative freshness rating scale to a Group M numerical rating between +3 (Group M selected as “Much Better”) and -3 (Group R or Group C selected as “Much Better”), with a 0 rating meaning both cases were equal, as detailed in Table 4. For each data set age grouping, these associated numerical ratings were then multiplied by the Figure 12 freshness rating percentages and summed across all rating levels to provide the composite relative Group M freshness ratings displayed in Figure 13.

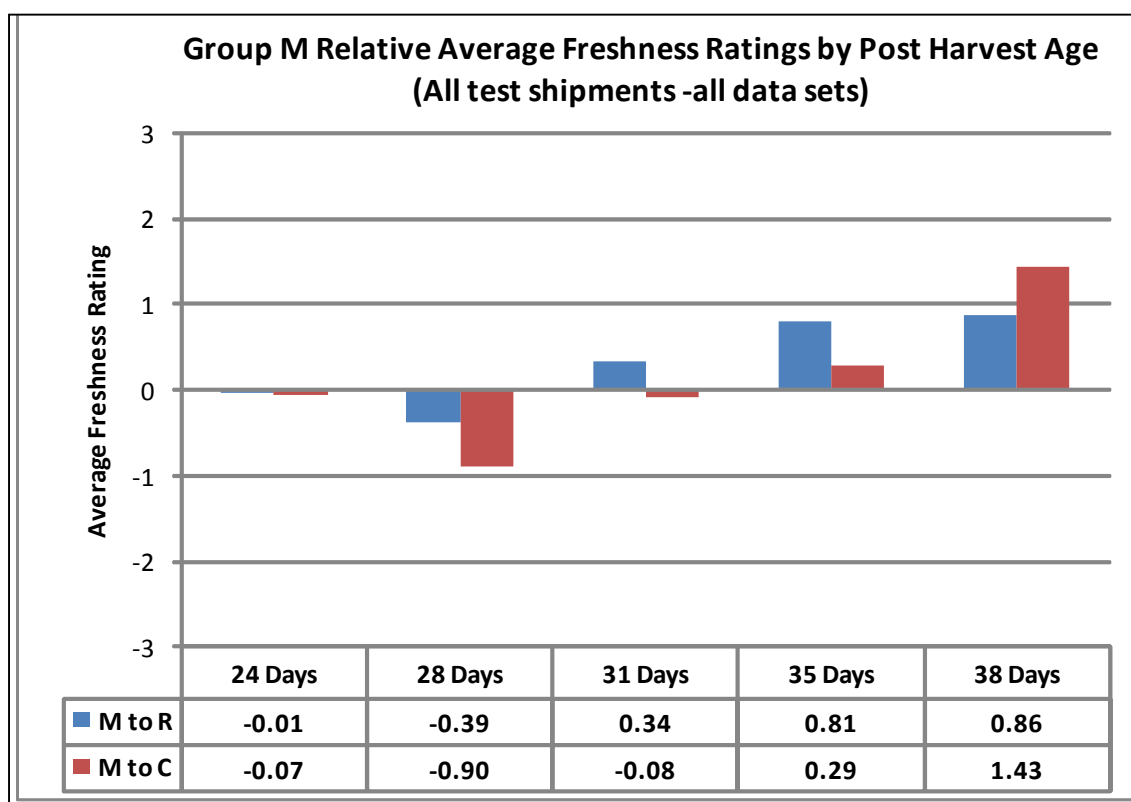


Figure 13. Iceberg Lettuce–Group M Average Relative Freshness Ratings

As Figure 13 shows, any differences in Group M product relative freshness compared to both Group R and Group C were small/minor and between “Slightly Better” (+1) and “Slightly Worse” (-1) for all post-harvest age groups up to 35 days. The 37-39 day post-harvest Group M to Group C comparison resulted in a composite Group M relative freshness rating of +1.43, between “Slightly Better” and “Moderately Better”.

3.1.5 Results of Test Group “Good-to-Serve” Case Yields

Figure 14 depicts the iceberg “Good-to-Serve” case yield results as a percentage of initial case product weight at Irvine, California. The supporting detailed data tables are provided in Appendix B. In Figure 14, the top chart presents the case yield results by data set, the middle chart by test shipment and age group, and the bottom chart by age group for all three shipments combined. As for the overall freshness ratings, the middle chart results are slightly offset from each other and in the following order: Week1, Week 2, Week 3.

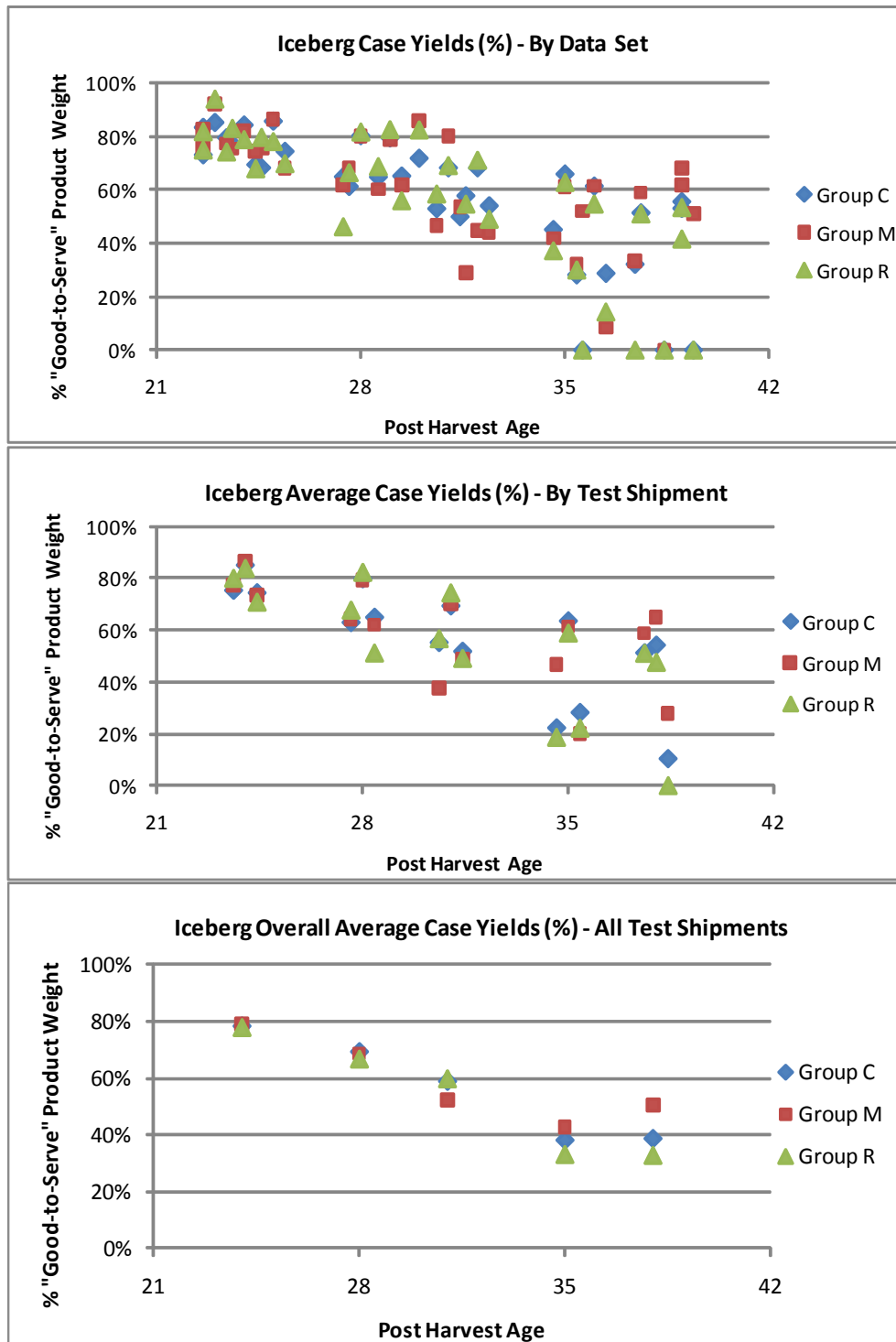


Figure 14. Iceberg Lettuce–“Good-to-Serve” Case Yields (%). Top: By Data Set; Middle: By Test Shipment; Bottom: All Test Shipments Combined

As shown in the by-data-set chart, there was less variation between test groups and data sets at lower post-harvest ages, and variations increased as the product post-harvest age increased. Total case discard (0% yield) for 35+ day post-harvest data sets included four Group R, three

Group C, and one Group M case. While the top and middle charts in Figure 14 reveal considerable variability in test group case yields between data sets and test shipments, the bottom chart shows very similar average case yields for all three test groups across all test data sets up to 35 days post-harvest and somewhat higher Group M case yield rates for the 38 day post-harvest age group data sets compared to both the Group R and Group C cases.

3.1.6 Summary of Iceberg Lettuce MAPS Test Results and Recommendations

Iceberg lettuce shelf life expectations by test group were Group M – 35+ days, Group C – somewhat lower, and Group R – the lowest at 21+ days. For the higher post-harvest age data sets, the extra Group M shelf life was expected to translate into higher relative “Good-to-Serve” case yields and overall freshness ratings. This was not the case, however, as the Group M product cases did not provide the expected 35+ day product shelf life or any extra product shelf life than the Group C and Group R test cases.

The average “Good-to-Serve” Group M case yield for the 30-32 day post-harvest data sets was 52%, which was lower than that for the Group C cases (59%) and the Group R cases (60%). For the 35-36 day post-harvest data sets, average Group M case yields were low at 43%, but somewhat better than the yields for Group C cases (38%) and Group R cases (33%). For both of these age groups, the Group M case yields were expected to be significantly higher than 50% and better than those for the other two test groups.

Similarly, average Group M overall freshness ratings for the 30-32 day post-harvest data sets were just 5.08 (5= “Neither Good nor Bad”) and lower than those for the Group C (5.49) and Group R (5.49), while the average Group M overall ratings for the 35-36 day data sets were just 4.38, but slightly better than those for Group C (3.88) and for Group R (3.50). Based on prior testing, the Group M average overall freshness ratings for the 30-32 and 35-36 day post-harvest data sets were significantly lower than expected.

For the Guam MAPS test, the lower-than-expected Group M product shelf life and associated “Good-to-Serve” case yields and product freshness ratings are likely attributable to less robust and more highly stressed initial product than that utilized for prior Navy MAPS testing. The product utilized for that project was “hand-selected” and as a result more robust, more perfect, and less stressed. For the Guam MAPS test, product was sourced through in-place DLA Troop Support – Pacific contracts with no special efforts to obtain “select” product or above normal starting quality product. As a result, the Guam MAPS test product cases were less robust to include Test Shipment 1 cases that were considered substandard due to extensive and above average external leaf breakage due to pre-harvest wind damage. In addition, the overall Guam Group M case repack process very likely induced greater product stresses than that for the Navy MAPS project.

From a review of the Guam MAPS product photos (product received at Irvine, California and Guam data sets) and noted test observations, Apio determined that the internal Group M core browning and lower-than-expected shelf life were both likely due to the less robust/more stressed initial product than that utilized for the Navy MAPS testing. In turn, the less robust/more stressed starting product likely generated a higher product respiration rate and a resulting

drawdown of the internal MAPS case liner oxygen level below the targeted level, triggering the internal core browning and reducing the product shelf life. If this was the cause, Apio indicated that this can be resolved with a simple adjustment to the BreatheWay™ membrane to allow a higher external-to-internal oxygen transmission rate.

Based on the positive results of the Navy MAPS project, the following actions are recommended prior to further MAPS testing of iceberg lettuce in another military supply chain:

- Develop improved iceberg lettuce MAPS repack procedures to reduce workload and any imparted product stress.
- Utilize DLA Troop Support sourced product to conduct further laboratory testing to determine the optimal BreatheWay™ membrane oxygen transmission rates for extending product shelf life.

3.2 Romaine Lettuce

3.2.1 External MAPS Test Factors

Table 8 details identified key external MAPS test factors (which were the same as those for the iceberg lettuce in Table 6) that potentially impacted the test data and results. Key points relative to the noted external factors include:

- The starting quality/condition of the Test Shipment 1 product was inferior to that of Test Shipments 2 and 3 due to pre-harvest wind damage and extensive breakage to the external leaves.
- MAPS case repack-induced product stresses were the highest for Test Shipment 1 and somewhat lower for the Test Shipments 2 and 3.
- Test Shipment 3 Group R and Group M product cases were negatively impacted due to 7 days of elevated container temperatures (40°F-50°F) above the target 33°F-34°F temperature.

Table 8. Romaine Lettuce – External MAPS Test Factors

External Factor	Test Group	Week 1	Week 2	Week 3
Initial Quality at Irvine, California receipt	All Groups (C, R, M)	Poor – Substandard, above average leaf breakage	Good – Typical, similar to Week 3, minimal leaf breakage	Good – Typical, similar to Week 2, minimal leaf breakage
MAPS Repack Product Stresses	Group M	Highest	Less – Same as for Week 3	Less – Same as for Week 2
Container Temperature Controls	Group C	Excellent (32°F-34°F)	Excellent (32°F-34°F)	Excellent (32°F-34°F)
	Group R	Excellent (32°F-34°F)	Excellent (32°F-34°F)	Poor final 7 days (40°F-50°F)
	Group M	Excellent (32°F-34°F)	Excellent (32°F-34°F)	Poor final 7 days (40°F-50°F)

3.2.2 General Guam Observations of Quality/Condition

Table 9 provides general observations noted across the Guam romaine lettuce data sets relative to product quality/condition. These general observations are based solely on actual appearance and evaluator comments/remarks prior to reduction/analysis of the collected data.

Table 9. Romaine Lettuce – General Guam Observations

Factor	Test Shipment	Test Group	Observation
Freshness/ Quality at Guam Receipt*	1	All	Each test group – Similar product quality/freshness. Lower quality/freshness than for Test Shipments 2 and 3 (due to excessive pre-harvest wind damage/leaf breakage).
	2-3	All	Each test group – Similar quality/condition for both shipments. Better product quality/condition than for Test Shipment 1.
Freshness/ Quality 7-10+ Days Post-Guam Receipt	1-3	All	Group M – Clearly highest product quality/freshness . Group R and C – Lower product quality/freshness with Group R clearly the lowest at 35+ days post- harvest.
	1-3	M	Group M – Higher “Good-to-Serve” case yields. Group R and C – Lower and similar “Good-to-Serve” case yields.

*At Guam receipt product was 23+ days post-harvest.

By test shipment, cases for each test group had similar overall product freshness appearances for the initial data sets received at Guam, 23-25 days post-harvest. For Test Shipment 1, however, the general product quality/freshness was somewhat lower than for Test Shipments 2 and 3. This is attributed to the extensive pre-harvest wind damage (leaf breakage) to the Test Shipment 1 product cases. Based on the expected by-test-group product shelf life, all three test groups were projected to exhibit similar freshness for the initial 23-25 day post-harvest data sets.

As product age increased, there were clearer distinctions in overall product freshness appearance between the three test groups. For data sets with a 30+ day post-harvest age (7-10+ days post-Guam receipt), the Group M case almost always exhibited the highest overall product freshness, the Group C product cases intermediate freshness, and the Group R cases the lowest product freshness. For the higher post-harvest age data sets, the Group M and Group C product cases were expected to exhibit better product freshness due to the expected extra shelf life as compared to the Group R cases. These general observations relative to by-test-group freshness appearances by data set age group were later confirmed by actual MAPS test data.

Relative to “Good-to-Serve” case yields for same-shipment 23-25 day post-harvest data sets, there appeared to be considerable variation in the by-test-group case yields between data sets. However across all 23-25 day post-harvest data sets, all three test groups appeared to provide similar “Good-to-Serve” case yields.

For the higher post-harvest age data sets, the Group M consistently exhibited higher “Good-to-Serve” case yields than Group R and Group C, which tended to be similar to each other. At 30+ days post-harvest, Group M and Group C were both expected to exhibit higher

“Good-to-Serve” case yields than Group R due to expected longer Group M and Group C product shelf life. These general observations relative to “Good-to-Serve” case yields as a function of post-harvest age were later confirmed by actual MAPS test data (Section 3.2.5).

3.2.3 Test Group Freshness Rating Results

This section contains freshness rating results based on the five freshness rating factors in the first part of the Freshness Rating Survey Form (provided in Appendix A) using the 9-point quality scale, as discussed in Section 2.7.1.1. The results for overall freshness are discussed in Section 3.2.3.1. The results of the other four factors (external appearance, internal appearance, smell/odor, and crispness/firmness/ springback) are briefly summarized in the following subsections and are detailed in Appendix C.

3.2.3.1 Overall Freshness

At the start of each data collection set, the three cases of romaine lettuce were opened and the product displayed for photos to document the quality/condition of the product for each test group case. Photos included one with the three test group cases side-by-side with the Group M case in the middle for direct visual comparison. Separate close-up photos of each test group case were also taken.

Figure 15 displays the resulting average overall freshness ratings (based on the 9-point scale) for romaine lettuce across the 34 data sets as a function of post-harvest age. The supporting detailed data tables are provided in Appendix C, along with similar charts and associated data tables for the other four rated freshness factors. The top chart of Figure 15 depicts the average test group overall freshness ratings by data set, the middle chart the average ratings by test shipment (average of the data set averages within a post-harvest age group), and the bottom chart the average ratings across all three test shipments (average of the three by-test-shipment averages). In the middle chart, the average ratings by test shipment are slightly offset and in the following order: Week 1, Week 2, Week 3.

As shown in Figure 15, at 23-25 days post harvest, there was considerable variation in the by-test-group average freshness ratings between data sets, more limited variation in between test groups by test shipment, and essentially no difference in the average by test group for all three shipments combined. Across the nine 23-25 day post-harvest data sets for three test shipments, the average data set ratings for each test group were similar and between “Moderately Good” (7) and “Very Good” (8), with Group R lowest at 7.35, Group C slightly higher at 7.69, and Group M the highest at 7.87. Figure 16 shows one of the 23-25 day post-harvest data sets (Magellan Data Set 1-1 from Test Shipment 1) that had similar ratings between test groups, which were similar to the overall ratings. The three 23-25 day post-harvest test groups were expected to exhibit similar overall freshness ratings based on the expected 21+ day product shelf life for Group R and longer 28-35+ day shelf life for Group C and Group M.

Figure 15 also shows, however, that for the 30+ day post-harvest data set that the Group M cases had the highest average overall freshness rating, that Group C cases had intermediate ratings, and that Group R cases had the lowest overall freshness ratings. For the 35-36 day age group data sets, the average Group M overall freshness rating of 6.30 was about one point higher

than that for the Group C cases at 5.23 and almost two points higher than that for the Group R cases at 4.44. Figure 17 provides photos from one of these data sets (Covington Data Set 2-4 from Shipment 2), clearly showing higher freshness in the Group M product than in the others.

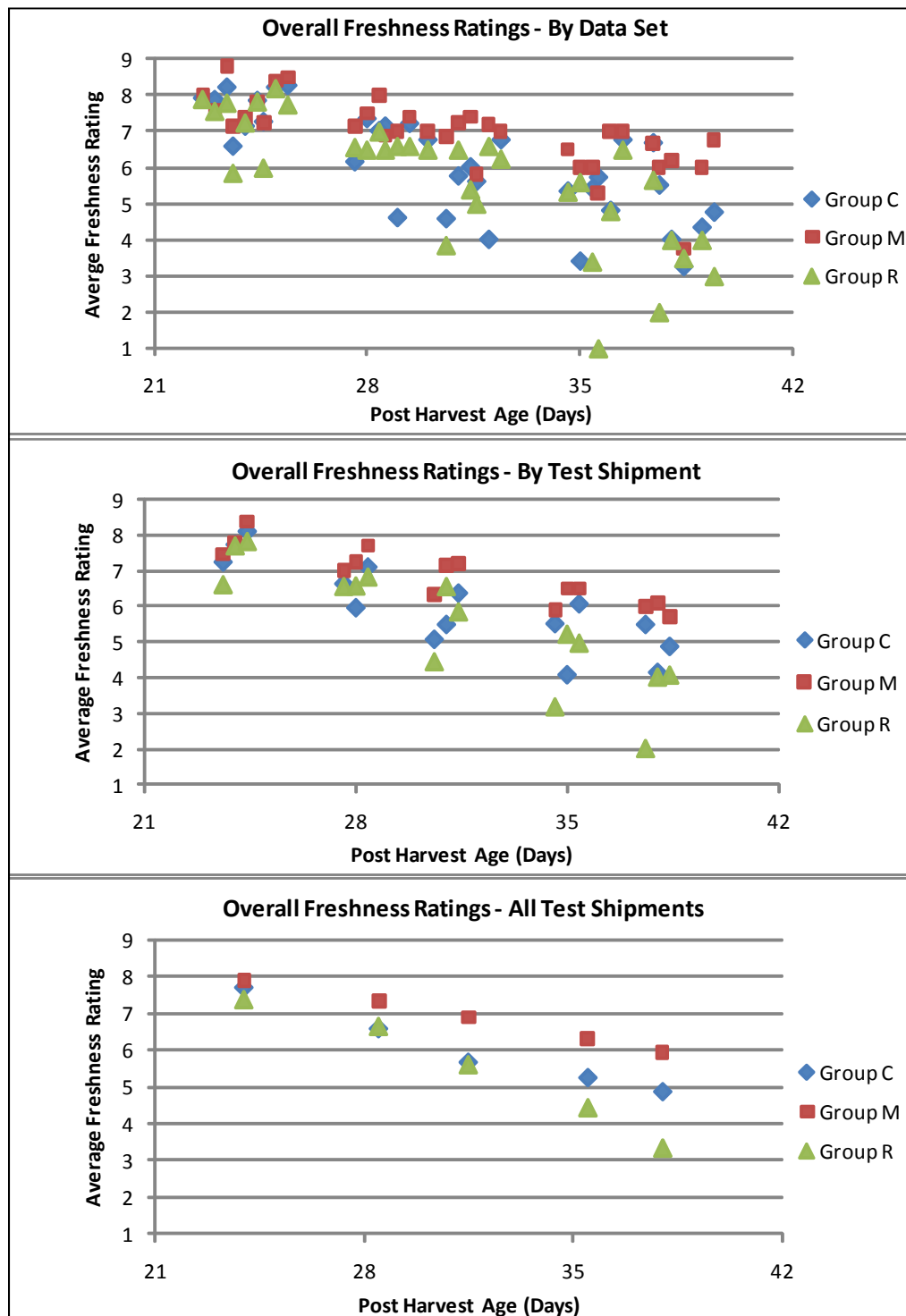


Figure 15. Romaine Lettuce – Overall Freshness Ratings by Test Group. Top: By Data Set; Middle: By Test Shipment; Bottom: All Test Shipments Combined



**Figure 16. Romaine Lettuce –23 Days Post-Harvest (Shipment 1, Magellan Data Set 1-1).
Left: Group R; Center: Group M; Right: Group C**

The results for the comparison of overall freshness ratings between test groups were similar for the 37-39 day post-harvest data sets. Based on the anticipated product shelf life for each test group, the Figure 15 overall freshness rating results were expected to include the clearly higher Group M overall freshness ratings for the 30+ day post-harvest data sets.

The observed problem of more frequent/severe internal core browning for the Group M iceberg lettuce cases was not observed with the Group M romaine lettuce cases.



**Figure 17. Romaine Lettuce –36 Days Post-Harvest (Shipment 2, Covington Data Set 2-4).
Left: Group R; Center: Group M; Right: Group C**

3.2.3.2 External Freshness

For similar post-harvest age data sets from the same test shipment, there was considerable variability in the average external freshness ratings between data sets. Furthermore, the variability increased with post-harvest age.

For all 23-25 day age group data sets, average external freshness ratings for each test group were similar by test shipment with the average ratings for Test Shipment 1 lower than those for Test Shipments 2 and 3. For the nine 23-25 day post-harvest data sets for all test shipments, the average test group external freshness ratings were between “Moderately Good” (7) and “Very Good” (8) with Group M the highest at 7.69, Group C in the middle at 7.38, and Group R the lowest at 7.14. The small differences in the ratings are not significant given the subjective nature of the freshness ratings and the small number of evaluators for some data sets.

For all 28-29 day age group data sets, average group external freshness ratings were also very similar. However, for the 30-32, 35-36, and 37-39 day age group data sets, the extra Group M product shelf life resulted in higher Group M average external freshness ratings than the other test groups, with the difference increasing with post-harvest age. For the 30-32 day age group data sets, the average Group M rating was 6.26 above “Slightly Good” (6), while the Group C and Group R average ratings dropped below “Neither Good nor Bad” (5) at 4.86 and 4.68, respectively. Similarly, for the 35-36 day age group data sets the average Group M external freshness rating at 5.36 remained favorable while the Group C and Group R average ratings declined to 3.40 and 3.09, respectively, between “Slightly Bad” (4) and “Moderately Bad” (3).

3.2.3.3 Internal Freshness

The relative average internal freshness ratings and trends by test group were quite similar to those for external freshness. Across all nine 23-25 day post-harvest data sets, the average internal freshness ratings were quite similar for the three product groups, between “Very Good” (7) and “Moderately Good” (8). However, similar to the internal freshness ratings, as the product post-harvest age increased, there was increased separation in the average internal freshness ratings between groups with Group M rated the highest, Group C intermediate, and Group R the lowest. Across all 31-32 day age group data sets, the average internal freshness ratings for the Group M, Group C, and Group R product were 6.79, 5.51 and 5.47 respectively. Similar results were observed for the 35-36 and 37-39 day age group data sets.

3.2.3.4 Smell/Odor

The general smell/odor freshness ratings and trends by test group were very similar to those for the other freshness factors. For all 23-25 day age group data sets, the average product freshness ratings by test group were similar, between “Moderately Good” (7) and “Very Good” (8), with Group M at 7.55, Group C at 7.52, and Group R at 7.29. As post-harvest age increased, similar to the other ratings, there was increased separation in the test group average smell/odor freshness ratings. For the 35+ day post-harvest data sets, Group M was clearly the highest, Group C in the middle, and Group R the lowest. For the six 35-36 day post-harvest data sets, the average Group M product case smell/odor rating at 6.02 was significantly better than the Group C and Group R ratings, which were below 5 (“Neither Good nor Bad”) at 4.88 and 4.29, respectively. Similarly, for the 36-39 day post-harvest data sets, the average smell/odor freshness ratings were Group M – 5.92, Group C – 4.91, and Group R – 3.34, respectively.

3.2.3.5 Crispness/Firmness/Springback

For the 23-25 day age group data sets, the average test group crispness/firmness ratings were similar to the other freshness ratings, between “Moderately Good” (7) and “Very Good” (8) with Group M – 7.95, Group C – 7.77, and Group R – 7.40. However, for the 35-36 and 37-39 day age group data sets there were two notable differences: (1) higher average ratings than for the other freshness factors and (2) reduced separation between the average Group M and Group C ratings, which were both clearly better than for the Group R ratings. For the 35-36 day age group data sets, average group crispness/firmness ratings were Group M – 6.68, Group C – 5.93, and Group R – 4.80. For the 36-39 day post-harvest data sets, the resulting freshness ratings were Group M – 6.30, Group C – 5.69, and for Group R – 4.15.

3.2.4 *Results of Overall Relative Freshness Rating Comparison of Test Groups*

This section contains results indicated for the group-to-group case comparisons (M to C, M to R, and C to R) in the second part of the Freshness Rating Survey (provided in Appendix A) that used rating levels and corresponding positive and negative numerical values to compare and rate the relative overall product freshness between two test groups, as discussed in Section 2.7.1.2.

Figure 18 depicts the results for these comparisons for all three test shipments by data set age group. The supporting detailed data tables are provided in Appendix D. In Figure 18, the table headings of a test group letter with a +, ++, or +++ reflect the designated test group letter being selected and rated as “Slightly Better”, “Moderately Better”, or “Much Better” relative to the comparison test group. The percentage of raters selecting each rating level was first computed for each data set, and each data set was aligned into one of the defined data set age groups. The percentage of raters selecting each rating level was then averaged across all within-age-group data sets to compute the percentages and bar charts depicted in Figure 18.

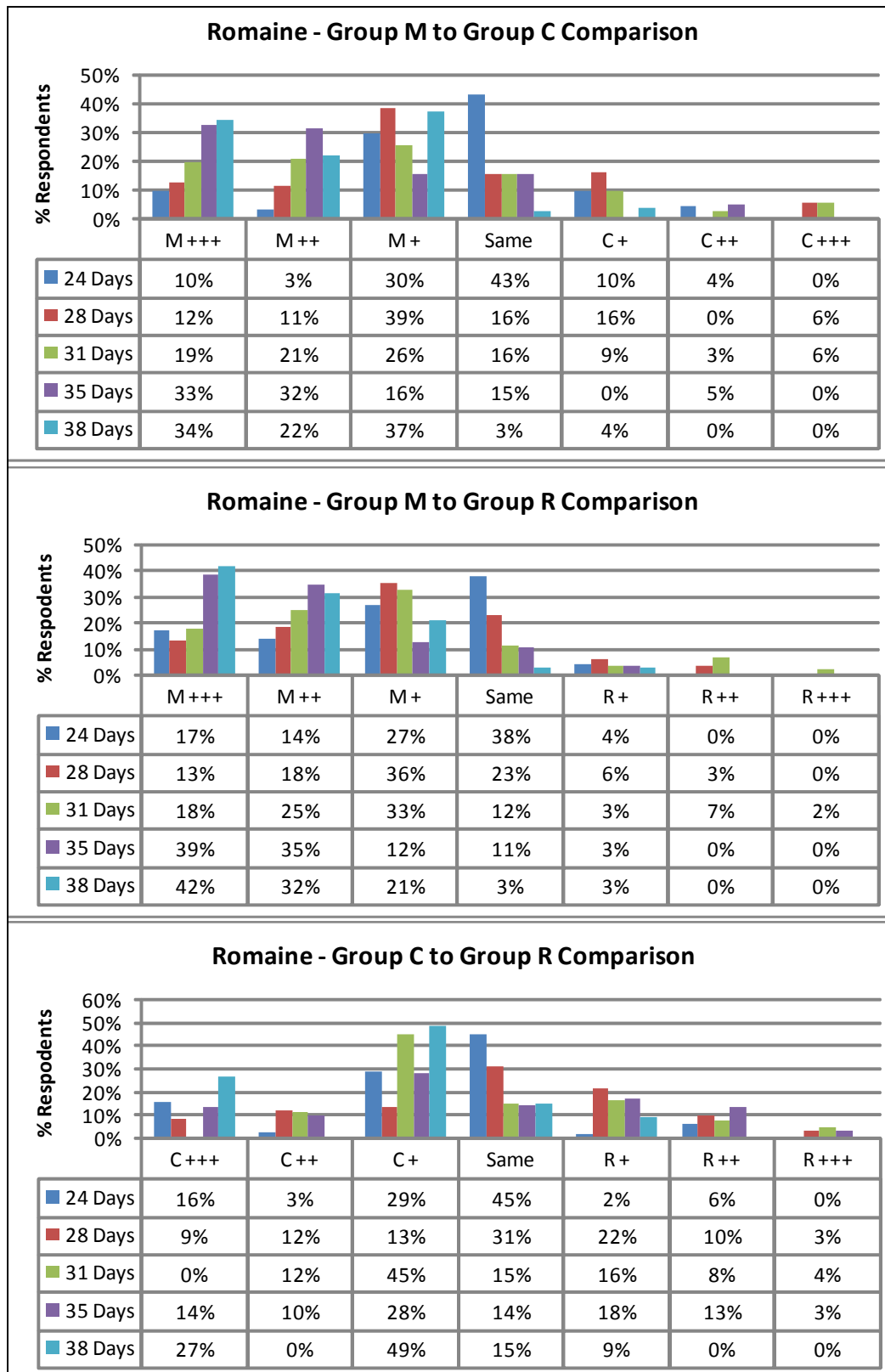


Figure 18. Romaine Lettuce – Comparison of Overall Freshness between Test Groups.
Top: Group M to Group C; Middle: Group M to Group R; Bottom: Group C to Group R

The top two charts in Figure 18 reveal that across all same-age-group data sets, a significantly higher proportion of raters identified the Group M product case as having better freshness than the Group C (top chart) and the Group R (middle chart) cases, with the difference increasing with post-harvest age. For all 24 day post-harvest data sets in the Group M to Group C comparison, 43% of the evaluators identified the Group M case as being fresher, 14% identified the Group C case as fresher, and 43% rated both equally fresh. For the 31 day post-harvest data sets, 66% of evaluators identified the Group M case as fresher, and only 18% selected the Group C case as fresher. For the 38 day post-harvest age group data sets, 93% of evaluators identified the Group M case as fresher, and only 4% selected the Group C case. The relative freshness results for the Group M to Group R comparison were very similar, with the Group M relative ratings being higher and increasing with post-harvest age. As depicted in the bottom chart in Figure 18, the comparison between Group R and Group C resulted in a higher dispersion across all relative freshness ratings, with no clear or consistent indication that the Group R or Group C cases were considered fresher. In fact, across all five age groupings, 60% or more of the evaluators selected a rating between the Group C case being slightly fresher and the Group R case being slightly fresher.

Figure 19 more clearly shows the composite relative freshness rating of the Group M cases compared to the Group R and Group C cases for each age group. The supporting detailed data tables are provided in Appendix D. Figure 19 was generated by converting the relative freshness ratings for the Group M to Group C and Group M to Group R comparisons to a Group M numerical rating of between +3 (Group M “Much Better”) and -3 (Group R or C “Much Better”), with a 0 rating meaning both cases were equal, as detailed in Table 4. These numerical ratings were then multiplied by the Figure 18 rating level percentages and summed across all rating levels to provide the composite relative Group M freshness ratings. As shown for the Group M to Group R relative freshness comparisons, the composite overall Group M ratings were significantly higher and near +1 (“Slightly Better”) for the 23-25, 28-29, and 30-32 day age group data sets and much higher, near +2 (“Moderately Better”), for the 35-36 and 37-39 day age data sets. For the Group M to Group C comparison, the Group M composite relative freshness ratings were positive, but less than +1.00 for the 23-25, 28-29, and 30-32 day data set age groups before increasing to +1.67 and +1.81 for the 35-36 and 37-39 day data set age groups.

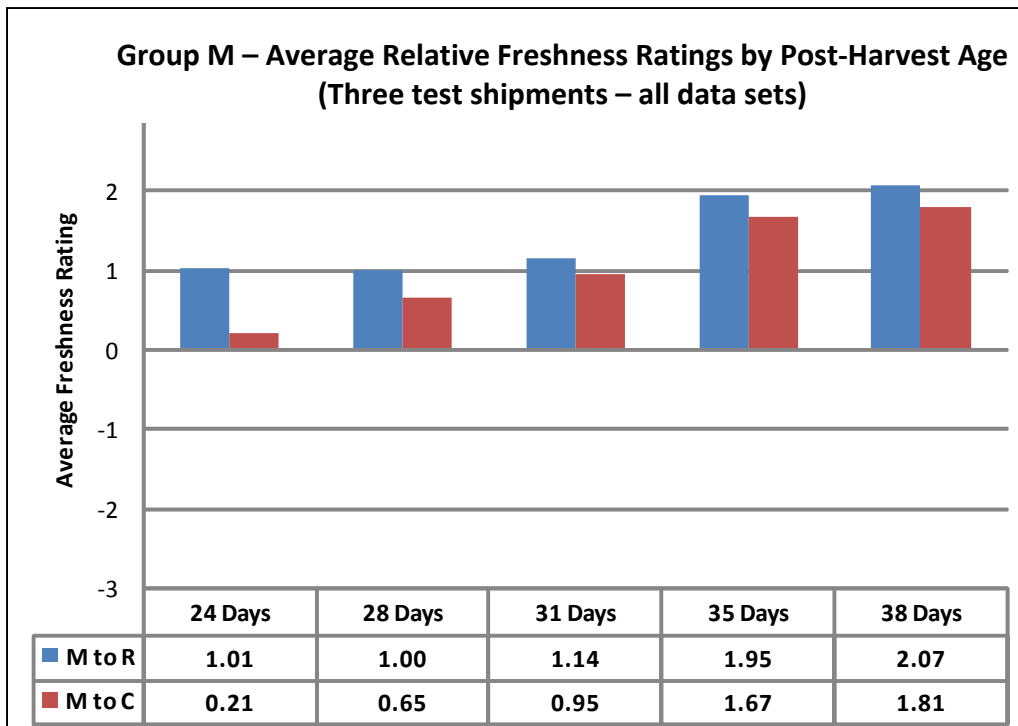


Figure 19. Romaine Lettuce – Group M Average Relative Freshness Ratings

3.2.5 Results of Test Group “Good-to-Serve” Case Yields

Figure 20 depicts the romaine lettuce “Good-to-Serve” case yield results as a percentage of the starting Irvine, California case product weight. The supporting detailed data tables are provided in Appendix B. The top Figure 20 chart depicts the “Good-to-Serve” case yields by data set, the middle chart by test shipment and data set age group, and the bottom chart by age group (for all test shipment data sets). For the by-test-shipment middle chart, the displayed results are slightly offset and in the following order: Week 1, Week 2, Week 3.

The top chart reveals considerable variation in case yields between same or similar post-harvest age data sets and that this variation increased with product post-harvest age which for 35+ day post-harvest data sets included total discard or 0% case yield for three Group R and three Group C cases. The middle chart shows that for the initial 23-25 day age group data sets average case yields by test shipment were similar for all three test groups and the highest for Test Shipment 1, in the middle for Test Shipment 2, and the lowest for Test Shipment 3.

The bottom chart reveals similar average case yields across all data sets at 23-25 days post-harvest: 73%, 71% and 69% for Group M, Group C, and Group R, respectively. However, as post-harvest age increased, the Group M average case yields became clearly higher than those for Group C and Group R, which remained very similar to each other. For the 35-36 and 37-39 day data sets, the differences in case yields were significant. The average relative Group M case yield at 35-36 days post-harvest was 73% higher than Group C and 90% higher than Group R (ratings of 57%, 33%, 30%, respectively). At 37-39 days post-harvest, the average relative Group M case yield was 227% higher than Group C and 193% higher than Group R (ratings of 44%, 13%, 15%, respectively).

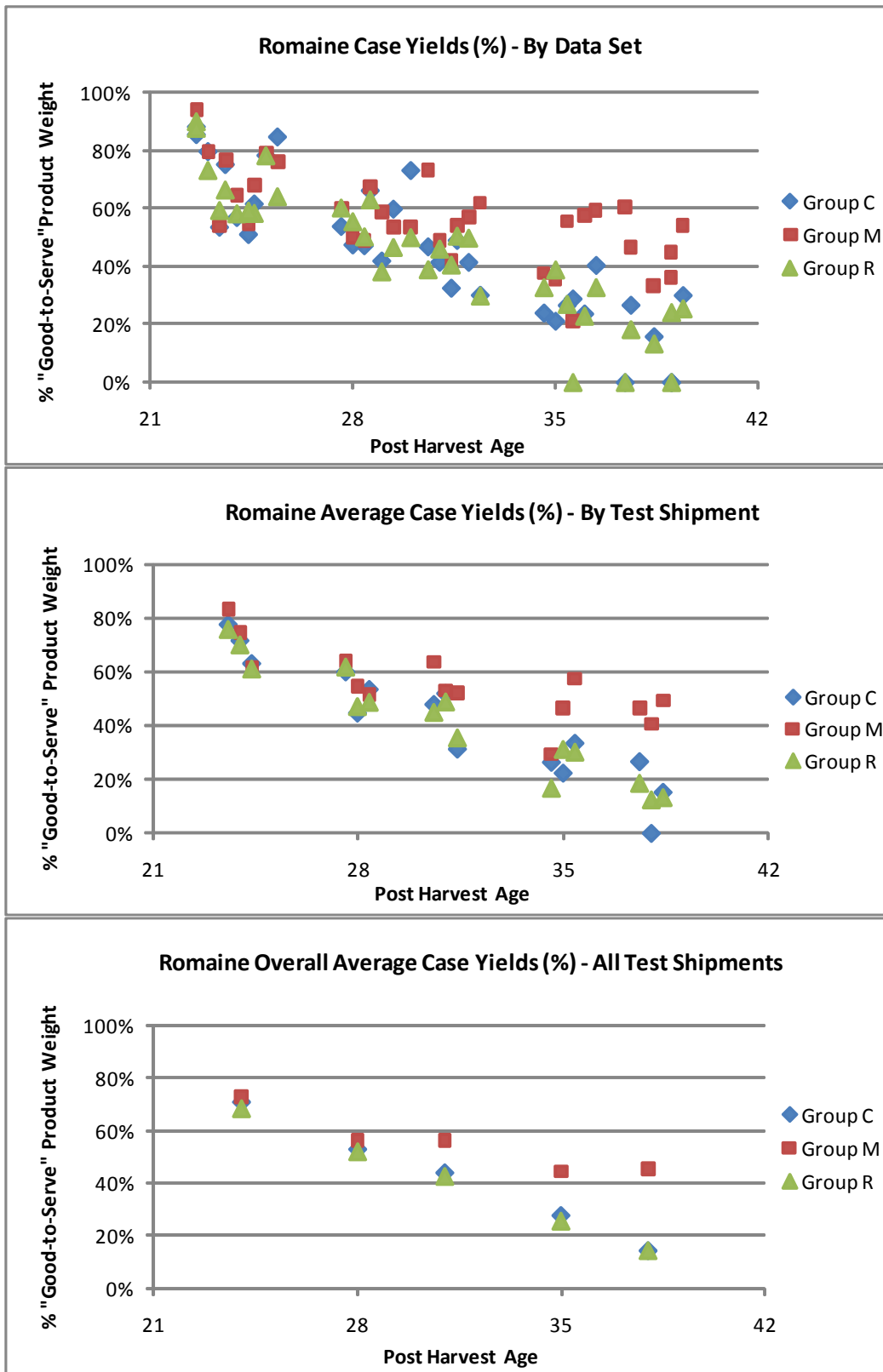


Figure 20. Romaine Lettuce – “Good-to-Serve” Case Yields (%). Top: By Data Set; Middle: By Test Shipment; Bottom: All Test Shipments Combined

3.2.6 Summary of Romaine Lettuce MAPS Test Results and Recommendations

Based on all Guam romaine lettuce data sets, the Group M product cases did not provide the expected 35+ day product shelf life, but they did provide longer shelf life than both Group C and Group R.

For the 23-25 and 28-29 day age group data sets, all three test groups had similar average “Good-to-Serve” case yields: 73%, 71%, 69% for Group M, Group C, and Group R, respectively, at 23-25 days post-harvest and 56%, 53%, 52%, respectively, at 28-29 days post-harvest. The average Group M, Group C, and Group R case yields were 56%, 44%, and 43%, respectively, at 30-32 days post-harvest and 44%, 27%, 26%, respectively, at 35-36 days post-harvest. On a relative case yield basis, this equates to an average extra case yield of 27% at 30-32 days post-harvest and 69% at 35-36 days post-harvest for Group M, compared to the associated yields for Group C and Group R.

For the 23-25 and 28-29 day age group data sets, all three test groups had similar average overall product freshness ratings, with only small differences (less than one point) between the groups. For the higher post-harvest age groups, the average overall Group M freshness ratings were clearly higher (> one point) than the Group C and Group R ratings, which were very similar to each other. The average Group M, Group C, and Group R overall freshness ratings were 6.89, 5.65, and 5.60, respectively, at 30-32 days post-harvest and 6.30, 5.23, and 4.44, respectively, at 35-36 days post-harvest.

The higher Group M “Good-to-Serve” case yields and average overall freshness ratings for the 30-32 and 35-36 day age group data sets clearly indicate that the Group M product had longer shelf life than Group C and Group R. However, based on an expected Group M product shelf life of 35+ days, the test Group M case yields for the 30 to 36 day post-harvest data sets were lower than expected. Part of the lower-than-expected “Good-to-Serve” may be attributable to a less robust/more stressed starting product plus greater Guam Group M case liner repack-imparted product stresses.

Prior to further testing in a military supply chain, the following items are recommended:

- Develop improved romaine MAPS case liner repack procedures to reduce repack workload and any repack-imparted product stresses.
- Use regularly-sourced DLA Troop Support supply chain products for further laboratory testing to determine if the BreatheWay™ membrane transmission should be adjusted to further extend Group M product shelf life.

3.3 Broccoli Crowns

3.3.1 External MAPS Test Factors

Table 10 details the identified external MAPS test factors that potentially impacted the DLA Troop Support broccoli test group results between test shipments, or relative results

between test groups for a specific test shipment. Key points and potential test group impacts of identified external test factors include:

Table 10. DLA Troop Support Broccoli–External MAPS Test Factors

External Factor	Test Group	Week 1	Week 2	Week 3
Product Quality at Irvine, CA Receipt	All Groups (C, R, M)	Good/Typical Similar all 3 weeks	Good/Typical Similar all 3 weeks	Good/Typical Similar all 3 weeks
DLA Troop Support SPV	All Groups (C, R, M)	Groups C&R – 1 st Source Group M – 2 nd Source	Groups C&R – 1 st Source Group M – 2 nd Source	Group C – 1 st Source Groups M&R – 2 nd source
Type Case Pack -iced or iceless	Group C	Plan – Iced Actual – Iced	Plan – Iced Actual – Iced	Plan – Iced Actual – Iced
	Group R	Plan – Iced Actual – Iceless	Plan – Iced Actual – Iceless	Plan – Iced Actual – Iced
	Group M	Plan – Iceless Actual – Iceless	Plan – Iceless Actual – Iceless	Plan – Iceless Actual – Iceless
MAPS Repack Product Stresses	Group M	Intermediate	Intermediate	Intermediate
Container Temperature Controls	Group C	Excellent (32°F-34°F)	Excellent (32°F-34°F)	Excellent (32°F-34°F)
	Group R	Excellent (32°F-34°F)	Excellent (32°F-34°F)	Poor Final 7 Days (40°F-50°F)
	Group M	Excellent (32°F-34°F)	Excellent (32°F-34°F)	Poor Final 7 Days (40°F-50°F)

- For Test Shipments 1 and 2, the Group R product cases were sent as iceless versus planned iced cases. Based on DLA Troop Support supply chain experience, Group R deviation likely negatively impacted the Test Shipment 1 and 2 Group R product quality and shelf life (as compared to likely results with iced cases).
- For each test shipment, the iced and iceless broccoli cases were sourced from two different vendors rather than the planned same-source vendor and product lot. This deviation potentially impacted the relative between-test-group results and comparisons.
- All CA and RA containers with MAPS test product effectively maintained target temperatures near 32°F-34°F except for the Test Shipment 3 RA container for which temperatures were significantly elevated and in the 40°F-50°F range for the final seven days. The elevated Test Shipment 3 RA container temperatures likely negatively impacted the Test Shipment 3 Group R and Group M results relative to the Test Shipment 3 Group C results (for which there were no CA container temperature control issues).

3.3.2 General Guam Observations of Quality/Condition

Table 11 summarizes general observations across all DLA Troop Support Guam broccoli crown data sets relative to general product freshness, quality, and condition by and between test groups at/near initial Guam delivery and over time. These represent general observations prior

to reduction/analysis of the collected test group freshness ratings and case yield data across all 32 DLA Troop Support broccoli crown data sets.

Table 11. DLA Troop Support Broccoli–General Guam Observations

Factor	Shipment	Test Group	Observation
Freshness/ Quality at Guam Receipt*	1-3	M	High product freshness (appearance, color, firmness, crispness, etc), 100% salad bar quality, no product case shrinkage.
	1-3	C	Product freshness very similar to/slightly lower than Group M product, 100% salad bar quality, slight product case shrinkage.
	1-2	R	Freshness/quality clearly lower than Group M or C cases. Top portion each case, crowns soft/rubbery and not crisp. Product case shrinkage estimated at 10-15%. Compared to Group C cases, reduced freshness perhaps due to iceless product
	3	R	Shipments 1 and 2 Group R, though plan was for iced cases. Higher quality/freshness and less case shrinkage than Shipments 1 and 2 (likely reason – iced product in Shipment 3 and iceless in Shipments 1 and 2).
Freshness/ Quality 7-10+ Days Post- Guam- Receipt	1-3	M	Maintained high initial product freshness/crispness, all product 100% salad bar quality, no observed product case shrinkage with extended on-site storage. Shipment 3 – some product yellowing likely due to elevated Shipment 3 container temperatures.
	1-3	C	Reduced product freshness/crispness compared to Group M. With longer storage time, product case shrink increased, and product became less crisp/more rubbery.
	1-3	R	Increased case shrinkage and 100% of product soft/rubbery and 0% salad bar quality/freshness.

*At Guam receipt product was 23+ days post-harvest.

At Guam delivery (23-25 days post-harvest), all Group M cases appeared 100% full, some Group C cases exhibited minor shrinkage, and all Group R cases exhibited shrinkage. The most noticeable change in product freshness post-delivery was in firmness/crispness/springback. The Group R product declined the fastest, Group C declined somewhat slower, and there was no noticeable decline/change over time in Group M. At Guam delivery, all Group M product was very firm/crisp, Group C was similar to slightly less firm/crisp, and both groups were 100% salad bar quality. However, the top 25-50% in each Group R case was somewhat soft/rubbery and below salad bar quality. Group C degraded to that level 7-10 days later, at which time 100% of the Group R product was soft/rubbery and only suitable for cooking (soups, stir fries, etc.).

3.3.3 Test Group Freshness Rating Results

In addition to the DLA Troop Support – Pacific broccoli, Shipments 2 and 3 included complete separate shipments of Apio broccoli to support the 12 Guam data sets. The Apio shipments were added due to concerns about whether the DLA Troop Support – Pacific FF&V contractor would be able to source the required iced and iceless broccoli cases from the same vendor and product lot. (Note: The DLA-Troop Support iced and iceless product cases were obtained from two different source vendors.) As a broccoli processor, Apio pulled all product

for the iceless Group M cases and the iced Group R and Group C cases, in both of its shipments, from the same product lot. Due to Guam partner dining facility time constraints, only 6 and 10 data sets were collected for the two Apio shipments, respectively, and most of those were collected at the SPV facility and involved fewer evaluators.

This section contains freshness ratings based on the five freshness rating factors in the first part of the Freshness Rating Survey Form (provided in Appendix A) using the 9-point quality scale, as discussed in Section 2.7.1.1. The results of overall freshness for both DLA Broccoli and Apio Broccoli are discussed in detail in Section 3.3.3.1. The results of the other four freshness factors (external appearance, internal appearance, smell/ odor, and crispness/firmness/springback) for DLA Broccoli only are briefly summarized in the following subsections and are detailed for both DLA Broccoli and Apio Broccoli in Appendix C.

3.3.3.1 Overall Freshness

DLA Broccoli. The two primary product attributes associated with overall freshness of the DLA broccoli crowns were product shrinkage and firmness/crispness/springback.

As post-harvest age of the broccoli increased, the visual indicators of product decay/spoilage were less pronounced than those observed in the iceberg and romaine lettuce. The primary visual changes in the broccoli crowns were increased shrinkage in Group R and Group C, more separation in the small florets in both Group R and Group C than in Group M, and more lightening of the previously dark green Group R and Group C broccoli crowns than in Group M. Near initial Guam receipt there was no noticeable Group M case product shrinkage, little to no Group C case shrinkage, and definite and more variable Group R shrinkage. As post-harvest age increased, the Group M cases remained 100% full with no noticeable shrinkage, the Group C shrinkage increased somewhat, and the Group R shrinkage was the most rapid and severe.

The product shrinkage for both the Group R and Group C broccoli was attributable to evaporative product moisture loss, which did not occur in the Group M cases due to the tightly closed MAPS case liner. For the same test shipment, at the same time, there were often very noticeable differences in the amount of product shrinkage between the Group R and Group C cases. This variation is likely linked to case location on the shipping pallet (e.g., top layer case or internal bottom layer case) and resulting case product exposure to potential evaporative losses.

Figures 21 to 23 depict the three broccoli test groups at three different post-harvest ages, from three different data sets. Figure 21 shows a Shipment 2 data set at 22 days post-harvest with (left to right) some Group R, but no noticeable Group M or Group C product shrink. Figure 22 depicts Shipment 1 product at 36 days post-harvest with significant Group R, noticeable Group C, but no Group M case product shrink. Figure 23 depicts Shipment 1 product from a different data set, at 42 days post-harvest with significant Group R and Group C but no Group M case shrinkage. Increased lightening and some yellowing of the Group R and Group C broccoli crowns were also noted in the 42 day post-harvest data set. Note: As the sole 40+ day post-harvest data set, this data set was not included as a separate age group in the overall analysis.

For each test shipment, the level of case product shrinkage was more severe for the Group R cases than for the Group C cases. The more severe Group R product shrinkage may be partly or wholly attributable to external test factors for each test shipment to include iceless rather than the planned iced Group R product cases for Shipments 1 and 2, and 7 days of elevated above-target RA container temperature for Test Shipment 3.



Figure 21. DLA Broccoli – 22 Days Post-Harvest (Shipment 2, SPV Data Set 2-1). Left: Group R; Center: Group M; Right: Group C



**Figure 22. DLA Broccoli – 36 Days Post-Harvest (Shipment 1, Covington Data Set 1-4).
Left: Group R; Center: Group M; Right: Group C**



**Figure 23. DLA Broccoli – 42 Days Post-Harvest (Shipment 1, SPV Data Set 1-6).
Left: Group R; Center: Group M; Right: Group C**

Figure 24 depicts the average overall freshness ratings by test group over time for the 32 DLA broccoli crown data sets. The associated detailed data tables are provided in Appendix C, along with similar charts and associated data tables for each of the other four freshness factors. The top chart in Figure 24 depicts the average overall freshness ratings by data set, the middle chart shows the average test group ratings by test shipment (average of the data set averages within a data set age group), and the bottom chart shows average test group ratings for all test shipments and data sets combined (average of the three by-shipment averages). The by-shipment ratings, in the middle chart, for each age group are slightly offset and in the following order: Week1, Week 2, Week 3. For each set of ratings, the Group M overall freshness rating tended to be slightly higher than the Group C rating, and the Group R rating was lower than the Group C rating and often a lot lower. Across the nine 23-25 day post-harvest data sets the average overall freshness ratings were Group M – 7.95, Group C – 7.48, and Group R – 5.47 on a 9-point scale. The Group M average overall freshness ratings stayed near 8 (“Very Good”) as post-harvest age increased from 23 days (at initial delivery) to 39 days, while the average Group C and Group R ratings both declined as post-harvest age increased. Across all 37-39 day data sets, Group M was just slightly lower at 7.72 while Group C declined to 6.29 and Group R declined to 4.11.

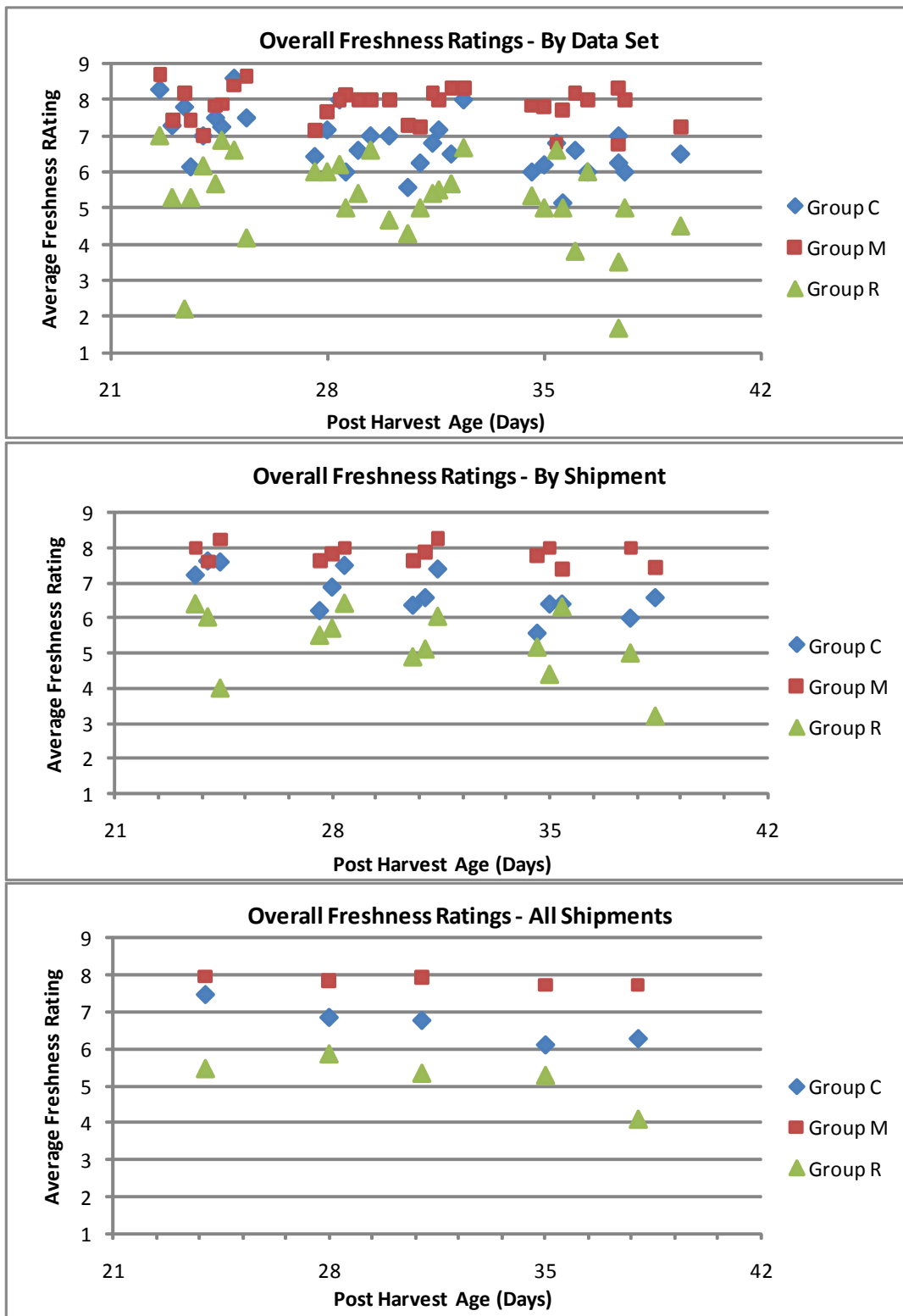


Figure 24. DLA Broccoli – Overall Freshness Ratings by Test Group. Top: By Data Set; Middle: By Test Shipment; Bottom: All Test Shipments Combined

During most of the Guam data sets, evaluators continually noted the high Group M case product firmness/crispness/springback and the large difference as compared to Group R and Group C products as post-harvest age increased. The maintenance of high Group M product firmness/crispness as post-harvest age increased is the likely reason Group the M product maintained high overall freshness ratings near 8, to include the 37-39 day post-harvest data sets.

Apio Broccoli. Figure 25 depicts average test group overall freshness ratings for the two test shipments by post-harvest age. The Shipment 2 ratings were slightly higher than the Test Shipment 3 ratings. The Apio broccoli results were quite similar to those for the DLA broccoli (Figure 24), with the exception of the Shipment 3 Group M overall freshness ratings. While Group M ratings for all three DLA shipments and Apio Shipment 2 stayed near 8 as post-harvest age increased from 23-25 days to 38-39 days, the Apio Shipment 3 Group M average ratings dropped significantly to 6.41 for the 35-36 day age group and to 4.98 for the 37-39 age group data sets, resulting in unexpectedly similar ratings for the three test groups in those Shipment 3 age groups. Potential reasons for the lower Apio Test Group M ratings in Shipment 3 include: the 7 days of significantly elevated Week 3 RA container temperatures, normal statistical variability associated with the small number of Apio data sets, fewer evaluators per data set, and the overall subjective nature of the freshness ratings.

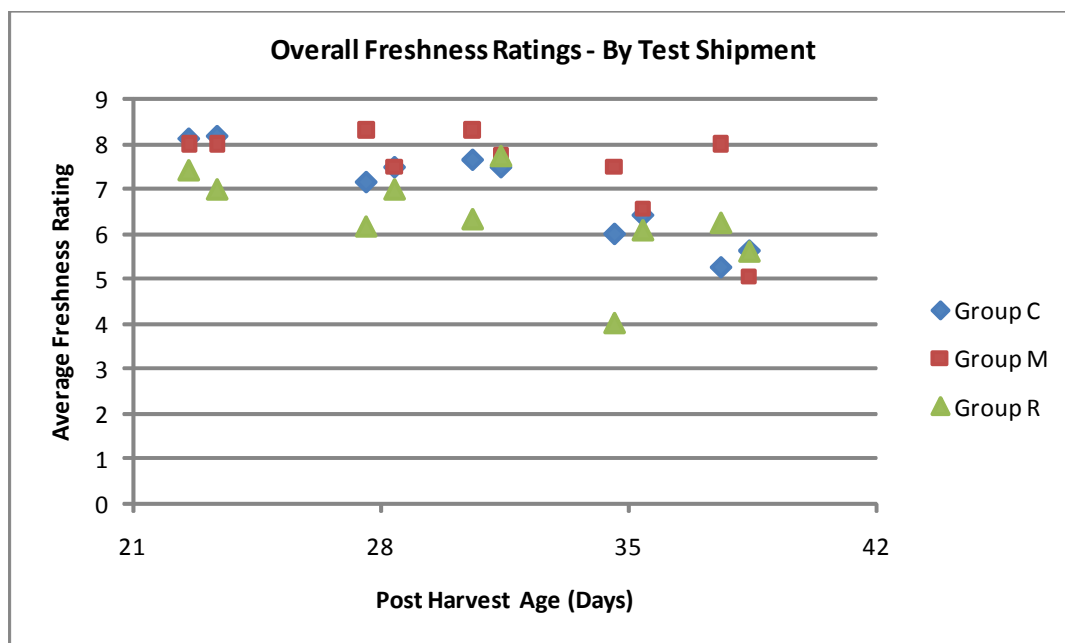


Figure 25. Apio Broccoli–Overall Freshness Ratings by Test Shipment

3.3.3.2 DLA Broccoli External Freshness

For similar post-harvest age data sets, the Group M product cases had the least variability in average external freshness ratings between data sets, Group C had slightly higher variability, and Group R had the highest.

For the 23-25 day post-harvest data sets, the Group M and Group C average external freshness ratings were very similar by data set, by test shipment, and across all data sets and were higher than those for Group R. Across the nine 23-25 day post-harvest data sets, average external freshness ratings were: Group M – 7.96, Group C – 7.67, and Group R – 6.14.

As product post-harvest age increased, declines in the external freshness ratings were minimal for Group M, higher for Group C, and highest for the Group R. For the 35-36 and 37-39 day post-harvest data sets, the average external freshness ratings were: Group M – 7.51 and 7.47, Group C – 6.05 and 5.99, and Group R – 5.68 and 3.60.

3.3.3.3 DLA Broccoli Internal Freshness

As with external freshness, variability in the average internal freshness ratings for similar post-harvest age data sets was the least for Group M, somewhat higher for Group C, and the highest for Group R. For the 23-25 day post-harvest data sets, the Group M and Group C average internal freshness ratings were similar by data set, by test shipment, and across all data sets and were also higher than those for Group R. For all nine 23-25 day post-harvest data sets, average internal freshness ratings were: Group M – 7.88, Group C – 7.43, and Group R – 5.91.

As post-harvest age increased, average internal freshness ratings for Group M product tended to stay high, near “Very Good” (8) while those for Group R and Group C declined, resulting in clearly higher average Group M ratings for the 30+ day post-harvest data sets. For the 35-36 and 37-39 day post-harvest data sets, the average internal freshness ratings were: Group M – 7.54 and 7.64, Group C – 6.28 and 6.44, and Group R – 5.89 and 4.53.

3.3.3.4 DLA Broccoli Smell/Odor

The general by and between test group smell/odor freshness ratings as a function of post-harvest age were very similar to the other freshness ratings. For similar post-harvest age data sets, the variability in average smell/odor ratings between data sets was the smallest in Group M, somewhat higher in Group C, and the highest in Group R. For the 23-25 day post-harvest data sets, the Group M and Group C average smell/odor ratings were quite similar for all data sets and higher than those for test Group R. For all nine 23-25 day post-harvest data sets, the average smell/odor ratings were: Group M – 7.66, Group C – 7.42, and Group R – 6.25.

As post-harvest age increased, average smell/odor freshness ratings for Group M tended to stay high and decreased only slightly while those for Group R and Group C declined more, resulting in clearly higher average Group M smell/odor ratings. For the 35-36 and 37-39 day post-harvest age groups, respectively, the resulting average smell/odor freshness ratings were: Group M – 7.55 and 7.17, Group C – 6.39 and 6.24, and Group R – 5.77 and 4.88.

3.3.3.5 DLA Broccoli Crispness/Firmness/Springback

Across the 32 DLA broccoli data sets, evaluators consistently noted higher firmness/cripness/springback of the Group M product cases compared to the Group C and Group R product cases. For 29 of the 32 data sets, the Group M product had the highest average

rating. The sole exceptions were the three 23-25 day post-harvest Test Shipment 2 data sets. Group C was rated slightly higher in two of those data sets, and Group M and Group C product were rated the same in the other data set.

For similar post-harvest age data sets, the variability in average crispness/firmness ratings was small for Group M cases, higher for Group C, and even higher for Group R product cases. The large variability in average Group R case firmness/crispness ratings is likely due to the iceless versus planned iced product cases for Test Shipments 1 and 2 and elevated RA container temperatures for Test Shipment 3. These factors likely contributed to the larger variability in Group R case product evaporative moisture losses depending on case pallet position (top pallet layer more exposed or lower pallet layer less exposed).

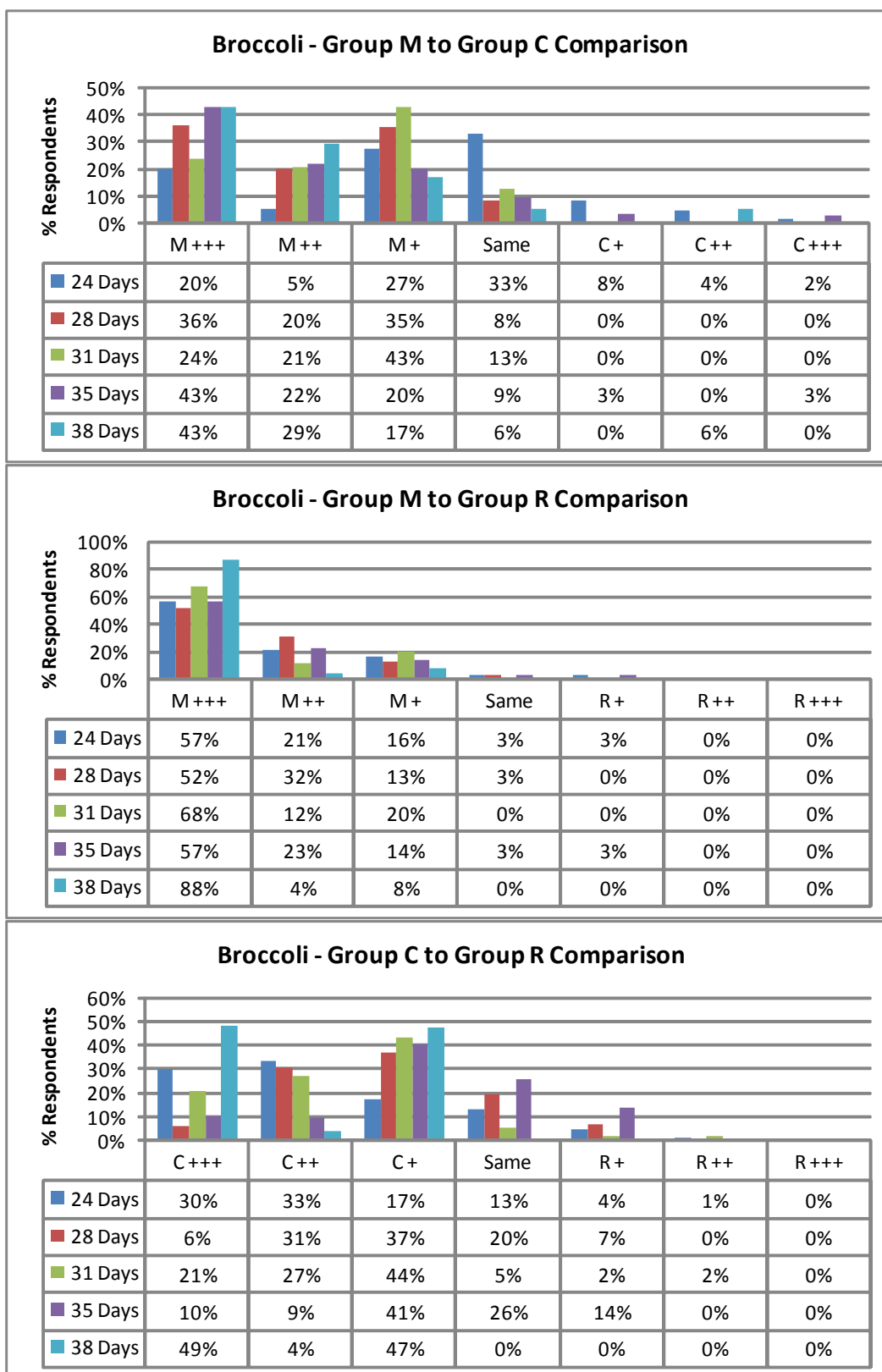
For the nine 23-25 day post-harvest DLA broccoli data sets, the Group M average data set firmness/crispness rating was 7.95. It was somewhat higher than that for Group C (7.48) and much higher than that for Group R (5.47). As post-harvest age increased, the average Group M product firmness/crispness ratings stayed high and near “Very Good” (8) while ratings for the Group C and Group R product cases declined, resulting in more separation between the higher average Group M product ratings, intermediate Group C ratings, and clearly lowest Group R ratings.

3.3.4 Results of Overall Relative Freshness Rating Comparison of Test Groups

This section contains results indicated for the group-to-group case comparisons (M to C, M to R, and C to R) in the second part of the Freshness Rating Survey (provided in Appendix A) that used rating levels and corresponding positive and negative numerical values to compare and rate the relative overall product freshness between two test groups, as discussed in Section 2.7.1.2

Figure 26 depicts the results for these comparisons for all three test shipments by data set age group. The supporting detailed data tables are provided in Appendix D. In Figure 26, the table headings of a test group letter with a +, ++, or +++ reflect the designated test group letter being selected and rated as “Slightly Better”, “Moderately Better”, or “Much Better” relative to the comparison test group. The percentage of raters selecting each rating level was first computed for each data set, and each data set was aligned into one of the defined data set age groups. The percentage of raters selecting each rating level was then averaged across all within-age-group data sets to compute percentages and bar charts depicted in Figure 26.

The top two charts in Figure 26 clearly show that across all 32 DLA broccoli data sets and all age groups, a very high percentage of evaluators selected the Group M product as having better overall freshness than the Group C product (top chart) and the Group R product (middle chart). The bottom chart shows that, across all data set age groups, the Group C case was clearly more frequently selected as having better overall product freshness than the Group R case.



**Figure 26. DLA Broccoli – Comparison of Overall Freshness between Test Groups.
Top: Group M to Group C; Middle: Group M to Group R; Bottom: Group C to Group R**

For the Group M to Group C product comparison across all 24 day age group data sets, 52% of evaluators identified the Group M case as being fresher, 33% considered the Group M and Group C cases equally fresh, and only 14% identified the Group C case as being freshness. For the higher data set age groups, the Group M to Group C relative freshness ratings were significantly higher, with 80-90% of all evaluators selecting the Group M case as fresher and only 0-6% selecting the Group C case as fresher. For the Group M to Group R case comparison, the Group M relative freshness ratings were higher across all data set age groups, with 94-100% of all evaluators identifying the Group M product case as fresher and 52-88% of all evaluators giving Group M the highest relative freshness rating (M+++).

Figure 27 very clearly depicts the higher composite Group M relative freshness rating as a function of post-harvest age. The supporting detailed data tables are provided in Appendix D. Figure 27 was generated by converting the relative freshness ratings for the Group M to Group C and Group M to Group R comparisons to a Group M rating of between +3 (Group M “Much Better”) and -3 (Group R or C “Much Better”), with a 0 rating meaning both cases were equal, as detailed in Table 4. These associated numerical ratings were then multiplied by the age group rating level percentages (Figure 26) and summed across all rating levels to provide the composite relative freshness ratings. Compared to Group R, the composite Group M ratings were significantly higher, between +2 (“Moderately Better”) and +3 (“Much Better”), for all five data set age groups. Compared to Group C, the Group M composite ratings were positive but not considered significant, > +1.00 (“Slightly Better”), for the 23-25 day age group, but they were higher and significant, between +1 (“Slightly Better”) and +2 (“Moderately Better”), for the other four age groups.

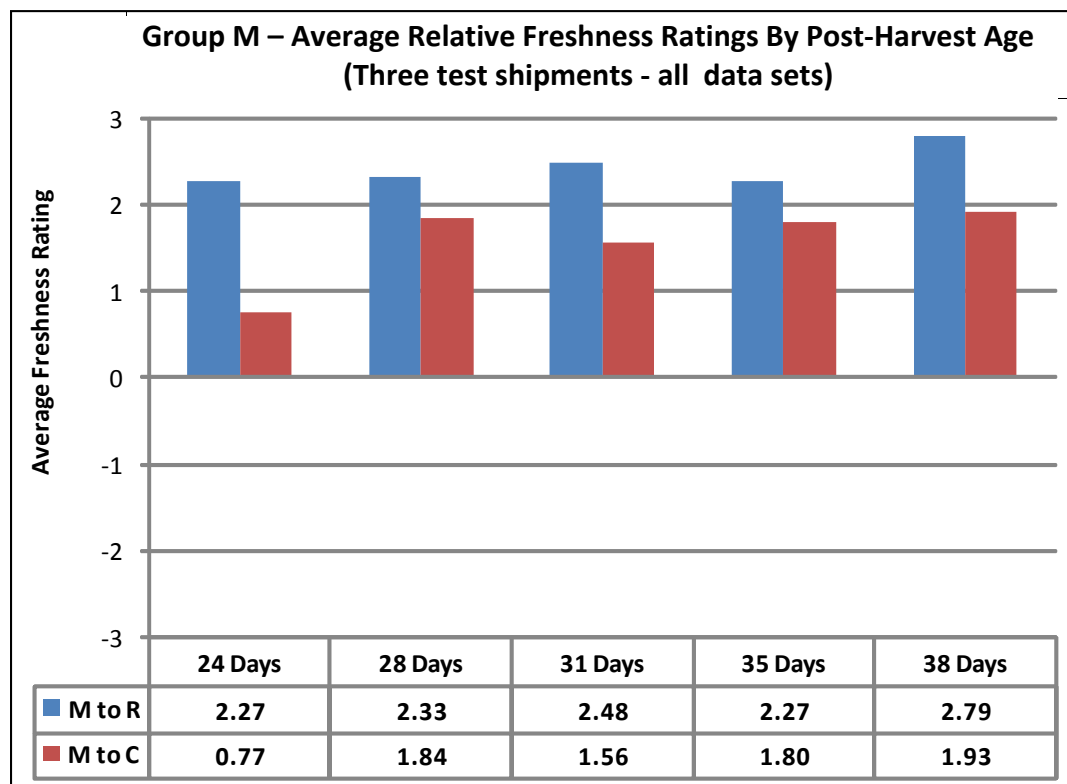


Figure 27. DLA Broccoli – Group M Average Relative Freshness Ratings

3.3.5 Results of Test Group “Good-to-Serve” Case Yields

DLA Broccoli. As mentioned in Section 2.7.2, the “Good-to-Serve” case metric for all broccoli test groups, unlike the iceberg and romaine lettuce groups, was solely in terms of post-culling product case weight. As a result, the recorded by-test-group, post-culling “Good-to-Serve” case weights could have been impacted by variations in initial product weight per case in addition to case culling discards due to substandard product quality and evaporative product moisture losses. Because of this, the resulting by-test-group broccoli “Good-to-Serve” measurement is a less reliable assessment metric than the iceberg and romaine “Good-to-Serve” case metric.

Figure 28 depicts the resulting DLA broccoli “Good-to-Serve” case yield in terms of post-culling product case weight (lb). The supporting detailed data tables are provided in Appendix B. The top chart in Figure 28 depicts the test group case yields by data set, the middle chart by test shipment and data set age group, and the bottom chart by data set age group for all three test shipments combined. For the middle chart the by-test-shipment and age group are slightly offset and in the following order: Week1, Week 2, Week 3.

The top chart shows that for most data sets the Group M “Good-to-Serve” case weight tended to be slightly higher than that for Group C and that the Group R case weight was almost always the least. With the exception of one Group C case, there was little variation in the “Good-to-Serve” case yields for data sets up to 35 days post-harvest. At that point, there were noticeable declines in the Group C and Group R case yields, with Group R declining noticeably more than Group C, though there was very little decline in Group M. For the 35+ day post-harvest data sets, the Group M case yields were 17% higher than Group C and 38% higher than Group R. Furthermore, the “Good-to-Serve” case yields depicted in Figure 28 included both salad bar and cooking-only quality product. If the culling standards would have allowed only salad bar quality product, the 30+ day post-harvest Group M case yields would have remained as shown. However, those for Group C would have declined by 25-50% more, and the Group R case yields would have declined to essentially zero, as almost all product was cooking-only quality.

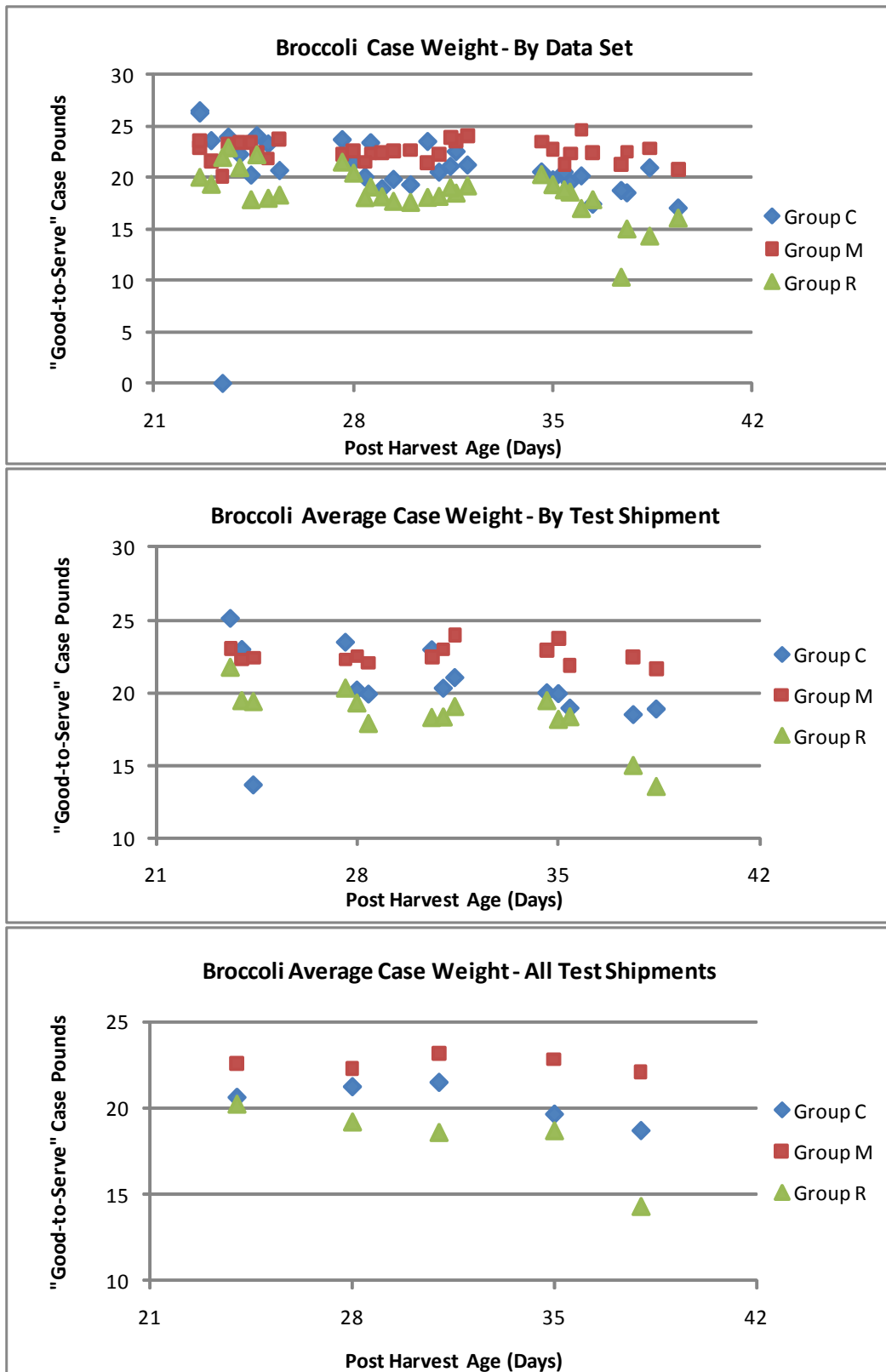


Figure 28. DLA Broccoli – “Good-to-Serve” Case Weights (lb). Top: By Data Set; Middle: By Test Shipment; Bottom: All Test Shipments Combined

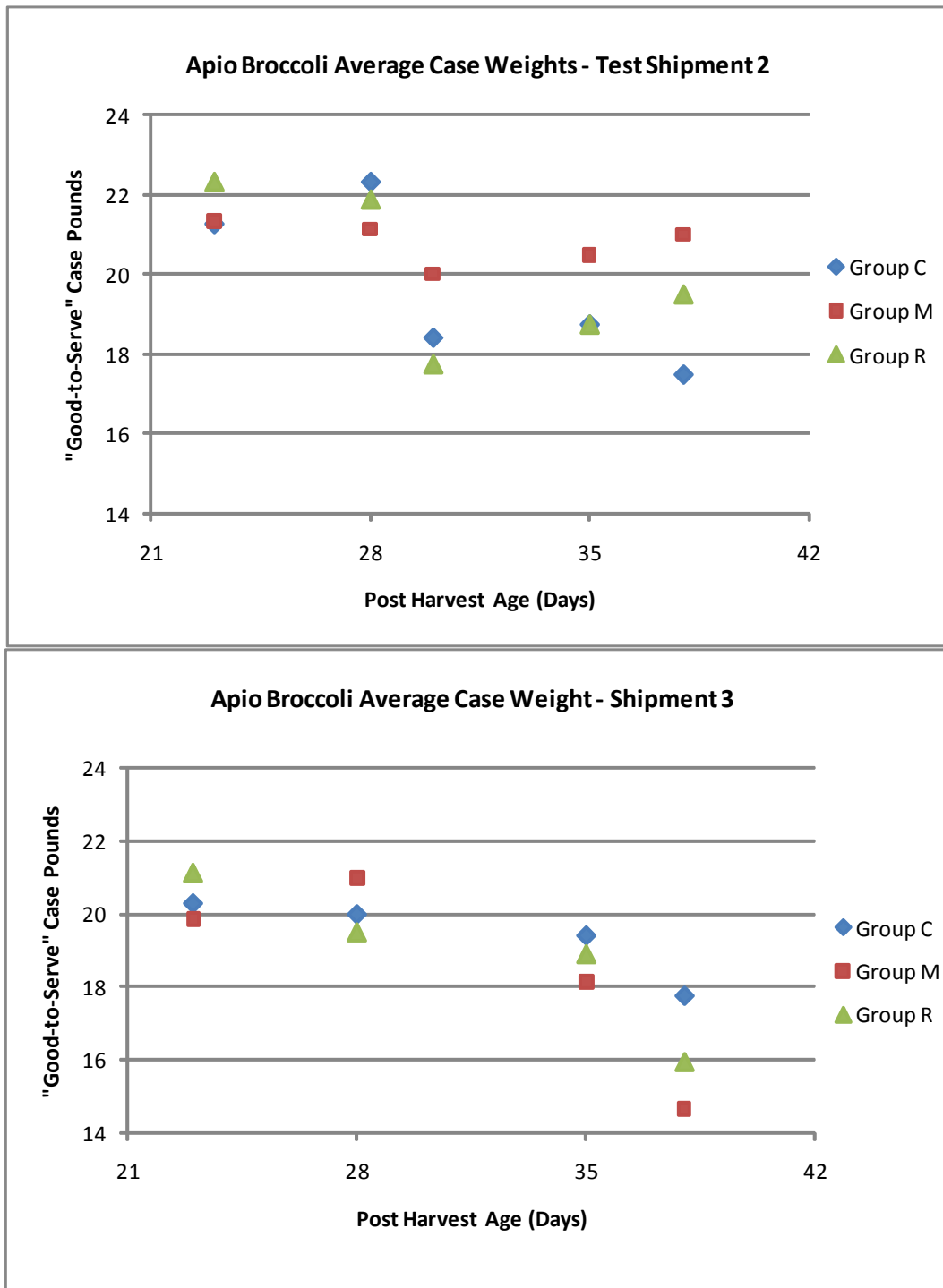
Apio Broccoli. Due to partner dining facility time constraints, only 9 and 10 sets of culled “Good-to-Serve” case product weights were collected for Apio Shipments 2 and 3, respectively, and most of these were collected by the Army Veterinary Corp personnel at SPV. [Note: Apio Shipment 2 had nine sets of “Good-to-Serve” case product weight data but just six sets of by-test-group freshness ratings. The reason for this is that three of the SPV Apio broccoli Shipment 2 data sets “culled” included two product cases for each test group (M, R, and C), for which only one set of product freshness ratings (based on both cases for each test group) were collected.

Figure 29 depicts the resulting average “Good-to-Serve” case yields for Apio Shipment 2 (top chart) and Apio Shipment 3 (bottom chart) by data set age group. For Shipment 3 there were no 30-32 day post-harvest (middle age group) data sets. The supporting detailed data tables are provided in Appendix B.

Across the three DLA and two Apio broccoli test shipments, Apio Shipment 2 broccoli was the only shipment for which no test group product was impacted by an identified external test factor. For Shipments 1 and 2, the DLA Group R cases were negatively impacted by iceless versus planned iced cases, and for Shipment 3 the DLA and Apio Group M and Group R cases were all negatively impacted by 7 days of significantly elevated RA container temperatures.

In Apio Shipment 2, for the initial 23-25 and 28-29 day age group data sets, the net “Good-to-Serve” case weights were quite similar for all three test groups, but higher for Group M for the 30+ day post-harvest age groups. However, as noted previously, due to the small number of data sets, the differences between test groups may also have been impacted (positively or negatively) by differences in actual starting product weight per case.

In comparison, in Apio Test Shipment 3, the test group “Good-to-Serve” case yields were similar for each data set age group up to 35-36 days post-harvest. For the 37-39 days post-harvest data sets there were clear differences in case yields between test groups, with Group C being the highest and Group M the lowest. While some/most of the difference may simply be due to variations in actual starting case product weights, a likely cause is the 7 days of significantly elevated RA container temperatures for the Shipment 3 Group M and Group R product cases, resulting in Group M and Group R product deterioration and negative culling discard impacts.



**Figure 29. Apio Broccoli – “Good-to-Serve” Case Weights (lb).
Top: Test Shipment 2; Bottom: Test Shipment 3**

3.3.6 Summary of Broccoli MAPS Test Results and Recommendations

For the Guam MAPS test, broccoli shelf life expectations were: Group M – 35+ days, Group C – more than Group R but less than Group M, and Group R – the lowest at 21+ days.

Based on all Guam DLA and Apio broccoli data sets, the Group M product cases clearly provided the expected 35+ day product shelf life. Also, the Group M product shelf life and freshness ratings were unquestionably greater than those for Group C, and the Group R product clearly had the least shelf life and lowest freshness ratings. At initial Guam receipt (23 days post-harvest), essentially all Group C product was still firm/crisp and considered salad bar quality, while for the Group R cases, about the top 25-50% of product in each case was already soft/rubbery and below salad bar quality. Based on firmness and crispness at receipt and over time, the Group C product maintained at salad bar quality for approximately 28-30 days while Group R product maintained at salad bar quality for less than 23 days. However, unlike the Group C product, each test shipment of Group R was likely negatively impacted by an external test factor: iceless versus planned iced Group R cases in Shipments 1 and 2 and significantly elevated Group R (and Group M) RA container temperatures in Shipment 3.

In terms of “Good-to-Serve” case yields, for all five data set age groups, Group M had the highest yields while Group C and Group R had intermediate and lowest yields, respectively. The Group M relative case yields for the 23-25 day and 35-39 day post-harvest data sets were 10% and 17% higher, respectively, than for the Group C cases and 12% and 38% higher, respectively, than for the Group R product cases.

In terms of average overall product freshness ratings, the Group M cases had the highest ratings for all five data set age groups while the Group C and Group R product had intermediate and lowest overall ratings, respectively. Also, as Group M overall freshness ratings stayed near 8 (“Very Good”) as post-harvest age increased, those for Group R and Group C declined. Across all 35-39 day post-harvest data sets, the resulting average Group M overall freshness rating was a much higher 7.72 as compared to 6.20 for Group C and only 4.70 for Group R.

In terms of relative overall freshness comparisons, the composite the Group M product was rated significantly better than the Group R product for all five age groups. It was also rated slightly higher for the initial 23-25 day post-harvest age group and significantly higher for the other four later age groups than the Group C product.

Based on the 35+ days product shelf life consistently demonstrated by both the DLA and Apio Group M broccoli product and its consistently high relative freshness ratings over time, no further testing of the MAPS case liner system for broccoli crowns is needed. However, prior to adoption in any military FF&V supply chain, it is recommended that the current MAPS case repack procedures be reviewed to reduce any product handling, associated time and workload impacts, and any repack-imparted product stresses.

4.0 Conclusions, Findings, and Recommendations

FF&V are extremely important to individual health, nutrition, and morale of the US armed forces. For several extended military supply chains, extra product shelf life provides several advantages and potential benefits: more cost effective end-to-end supply distribution options; reduced supply chain product losses/discards; fresher, higher quality product at the point of consumption; less frequent end customer deliveries which generate significant logistical support/force protection impacts; etc.

Based on the results of the Navy MAPS project laboratory testing, the MAPS case liner was expected to significantly extend the product shelf life for the Group M iceberg lettuce, romaine lettuce, and broccoli crown cases from on average about 21 days to 35+ days. By test item, the Guam supply chain test data demonstrated the following Group M shelf life extension benefits:

- Iceberg Lettuce – No Group M shelf life extension benefits. Across all data sets, average Group M product freshness ratings and “Good-to-Serve” case yields were similar to those for Group R and Group C.
- Romaine Lettuce – Group M cases had extra shelf life as compared to Group R and Group C cases, but less than the expected 35+ days. For 30+ day post-harvest data sets, Group M product freshness ratings and “Good-to-Serve” case yields were significantly better than those for both Group R and Group C cases, which were similar to each other.
- Broccoli Crowns – Test data demonstrate that Group M product shelf life was 35+ days. Across all data set post-harvest ages, Group M consistently had the highest product freshness ratings and “Good-to-Serve” case yields while Group C had intermediate ratings and Group R had the lowest ratings.

While the Guam MAPS test results validated the expected 35+ day shelf life only for broccoli crowns, the Guam test data results clearly demonstrate that the MAPS case liner “as tested” was cost-effective for those supply chains requiring extra product shelf life. That is, the MAPS system increased net “Good-to-Serve” case yields that generated savings (resulting from fewer cases procured to support end customer demands, reduced supply chain losses/discards, etc.) that exceeded the extra costs (time and labor) incurred to procure the MAPS case liner and repack the MAPS cases.* With adjustments to the MAPS case repack procedures and MAPS liner performance characteristics, both shelf life and case yields are expected to increase, which would make use of the MAPS case liner even more cost effective from an end-to-end supply chain perspective.

In addition, the test observations, data, and lessons learned from the Guam MAPS testing provided essential insights into likely required Group M technology and operational adjustments to improve the shelf life extension benefits of the tested MAPS case liner for both iceberg and romaine lettuce. These include:

* The data supporting this conclusion is not detailed in this report due to proprietary contract pricing information.

- Iceberg and Romaine Lettuce – The need for improved MAPS case liner repack process to make it more efficient and, more importantly, to reduce any product-handling requirements and associated incremental repack-imparted product damage and stresses.
- Iceberg Lettuce – The need to adjust the MAPS case liner membrane to permit a higher external-to-internal MAPS case liner O₂ transmission rate.

For the Guam test the starting quality/condition of the DLA Troop Support product was lower/less robust and more stressed than the “hand-selected” product utilized for prior laboratory testing. This difference, coupled with greater Guam test Group M case repack-imparted product damage and stresses likely caused higher product respiration rates and drawdown of the internal case liner O₂ levels below the targeted level, thus resulting in internal core browning and more rapid decay.

Therefore, the following actions should be taken as early as possible in order to improve performance of the MAPS system and increase its potential benefits:

- Develop improved Group M case liner repack procedures in general and perhaps specific to a particular item in order to reduce the amount of any required product handling and eliminate/minimize any resulting repack-imparted product damage and stresses.
- Conduct laboratory testing with multiple shipments of actual DLA Troop Support supply chain sourced products to assess and determine the optimum MAPS case liner membrane permeability parameters for maximum product shelf life.

When these actions are successfully completed, follow-on testing and evaluation of the MAPS case liner and other technologies should be conducted in other extended military FF&V supply chains.

This document reports research undertaken at the U.S. Army Natick Soldier Research, Development and Engineering Center, Natick, MA, and has been assigned No. NATICK/TR- 12/013 in a series of reports approved for publication.

List of Acronyms

AFB	Air Force Base
BAA	Broad Area Announcement
CA	Controlled Atmosphere
CFD	Combat Feeding Directorate
CO ₂	Carbon Dioxide
CONUS	Continental US
Covington	Navy Seabee Camp Covington Dining Facility, Naval Base Guam
DeCA	Defense Commissary Agency
DLA	Defense Logistics Agency
FF&V	Fresh Fruits and Vegetables
Group C	Commercial Pack, Controlled Atmosphere Container
Group R	Commercial Pack, Regular Atmosphere Container
Group M	MAPS Case Liner, Regular Atmosphere Container
Magellan	Magellan Dining Facility, Andersen Air Force Base
MAPS	Modified Atmosphere Packaging System
NSRDEC	Natick Soldier Research, Development and Engineering Center
O ₂	Oxygen
ONR	Office of Naval Research
RA	Regular Atmosphere
REI	Raymond Express International
SEET	Systems Equipment and Engineering Team
SPV	Subsistence Prime Vendor
TIPS	Technology Insertion Program for Savings

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Appendix A

Guam MAPS Test Data Collection Forms

Two primary data collection forms were utilized to assess the supply chain product discard rates and net “Good-to-Serve” case yields for each item across the three test groups. To support planned data collection, a label with a unique case code or number was placed on each product case in Irvine, California prior to initial case weighing. The assigned case codes uniquely identified each product case to include its test group and specific weekly shipment. Each case code began with a letter (M, C, or R) to identify the test group followed by a two-digit number that together uniquely identified each case. Week 1 case numbers were from 1 to 14, Week 2 from 21 to 34, and Week 3 from 41 to 54.

Figure A-1 presents the data collection form to record product case codes and associated gross case weights in Irvine, California prior to container load-out for ocean transport. The recorded gross case weights included both the fiberboard case weight plus the content of product weight.

For each Guam data collection set, Figure A-2 presents the data collection form to record the required case codes and the pre and post-culling case weights. Each Guam data collection set almost always consisted of one Group M, Group C, and Group R case for each produce item. The recorded “Starting Case Weight” represents the total case weight (fiberboard case weight plus content weight) prior to the start of culling to remove and discard any poor quality product not suitable for immediate consumption. The “Good-to-Serve” case weight represents the remaining total case weight (fiberboard case weight plus remaining content weight) after the completion of case culling.

For each produce item, the resulting assessment of supply chain loss/discard rates and net “Good-to-Serve” case yields was based on the Irvine, California start-of-supply-chain case weight data recorded on the Figure A-1 data form, and the Guam end-of-supply-chain case weight data recorded on the Figure A-2 data form for each data collection set.

For the three Guam MAPS test shipments, no product quality or freshness ratings were collected at the start of the supply chain or prior to container load out in Irvine, California. Since the quality/freshness ratings of fresh cut mature items can only decline with extended storage, front end supply chain test protocols for each test item focused on ensuring that all cases across the three test groups were as similar to each other as possible to include same initial quality, same date of pack, and same lot.

For each Guam MAPS test data set, Figure A-3 presents the two-page data form (two slightly different versions) to collect the end-of-supply-chain product freshness ratings. For each data set, the raters completed a separate Freshness Rating Survey form for each MAPS test produce item (iceberg, romaine, and DLA Troop Support sourced broccoli, and sometimes Apio broccoli).

The first part of the Freshness Rating Survey focused on collecting the raters’ assessment of each test group case in terms of five different freshness factors:

1. External appearance
2. Internal appearance
3. Smell/Odor
4. Crispness/firmness/spring back
5. Overall freshness

After rating each test group case for five freshness factors, the next part (top of page two of the form), consists of three questions that ask the rater to compare the overall relative freshness between cases for two test groups. For each comparison, the options are to rate the cases as “Both the Same” or to identify one test group as “Slightly Better”, “Moderately Better”, or “Much Better” than the other.

As mentioned earlier, there were two different versions of the Freshness Rating Survey form with the only difference being the order of these three pair-wise comparison questions. For example, the first question for Version 1 (Figure A-3) of the form was:

Freshness Rating Survey (Version 1)

Please provide your rating of the **overall freshness of Case C compared to Case R.**

Case C Much Better	Case C Moderately Better	Case C Slightly Better	Both the Same	Case R Slightly Better	Case R Moderately Better	Case R Much Better

For Version 2 of the Freshness Rating survey, the order of the cases in the question and rating scale were reversed.

Freshness Rating Survey (Version 2)

Please provide your rating of the **overall freshness of Case R compared to Case C.**

Case R Much Better	Case R Moderately Better	Case R Slightly Better	Both the Same	Case C Slightly Better	Case C Moderately Better	Case C Much Better

For the data collection sets, both versions were utilized to reduce any potential bias due to order of the cases in the actual question or position (left or right) of each case in the rating scale.

The final part of the Freshness Rating Survey asked the rater to identify any cases that they would completely discard without “culling” due to poor condition/quality and provide any additional notes/comments relative to product quality, condition, and/or freshness.

FF&V Product Case Starting Weights (Irvine, CA)

Week: 1 2 3

Date: _____

FF&V Item _____

Source Vendor _____

Lot Number _____

Harvest Date _____

Group C		Group R		Group M	
Case No.	Wt	Case No.	Wt	Case No.	Wt
C__		R__		M__	
C__		R__		M__	
C__		R__		M__	
C__		R__		M__	
C__		R__		M__	
C__		R__		M__	
M__		R__		M__	
M__		R__		M__	
M__		R__		M__	
M__		R__		M__	
M__		R__		M__	
M__		R__		M__	
				M__	
				M__	

Figure A-1. Starting Gross Case Weights (Irvine, CA)

Guam Data Set FF&V Case Weight Data

Dining Facility: _____

Date: _____

Data Set: _____

Product	Case Code	Starting Case Weight	Good-to-Serve Case Wt	Case Code	Starting Case Weight	Good-to-Serve Case Wt
Broccoli						
Broccoli						
Broccoli						
Iceberg						
Iceberg						
Iceberg						
Romaine						
Romaine						
Romaine						

Individual names (or codes) who “culled” product cases

Broccoli: _____

Iceberg: _____

Romaine: _____

Figure A-2. Data Set Case Weights (Guam)

Print Name _____ Date _____ Facility _____ Data Set _____

For each produce item, the evaluation includes three different groups of product cases labeled R for regular atmosphere, C for controlled atmosphere, and M for Modified atmosphere. We are interested in your honest assessment of the freshness and quality of today's cases from each of the three groups for each produce item.

Produce item being rated (Circle One): Iceberg Lettuce Romaine Lettuce Broccoli Crowns

Case R (Regular Atmosphere): Please rate this case produce on each of the following.

Rating Factors	Extremely Poor	Very Poor	Moderately Poor	Slightly Poor	Neither Good nor Poor	Slightly Good	Moderately Good	Very Good	Extremely Good
External Appearance									
Internal Appearance									
Smell/odor									
Product crispness firmness, spring back									
Overall freshness -- all factors									

Case M (Modified Atmosphere): Please rate this case produce on each of the following.

Rating Factors	Extremely Poor	Very Poor	Moderately Poor	Slightly Poor	Neither Good nor Poor	Slightly Good	Moderately Good	Very Good	Extremely Good
External Appearance									
Internal Appearance									
Smell/odor									
Product crispness firmness, spring back									
Overall freshness -- all factors									

Case C (Controlled Atmosphere): Please rate this case produce on each of the following.

Rating Factors	Extremely Poor	Very Poor	Moderately Poor	Slightly Poor	Neither Good nor Poor	Slightly Good	Moderately Good	Very Good	Extremely Good
External Appearance									
Internal Appearance									
Smell/odor									
Product crispness firmness, spring back									
Overall freshness -- all factors									

Figure A-3. Freshness Survey Rating Form

The next three questions ask you compare the overall freshness between two case groups.

Please provide your rating of the **overall freshness of Case C compared to Case R.**

Case C Much Better	Case C Moderately Better	Case C Slightly Better	Both the Same	Case R Slightly Better	Case R Moderately Better	Case R Much Better

Please provide your rating of the **overall freshness of Case M compared to Case R.**

Case M Much Better	Case M Moderately Better	Case M Slightly Better	Both the Same	Case R Slightly Better	Case R Moderately Better	Case R Much Better

Please provide your rating of the **overall freshness of Case C compared to Case M.**

Case C Much Better	Case C Moderately Better	Case C Slightly Better	Both the Same	Case M Slightly Better	Case M Moderately Better	Case M Much Better

Would you totally discard any of today's cases due to poor product condition, quality, or spoilage?
If YES, which specific cases?

Please provide any other comments/feedback you have relative to the condition, quality, or freshness of today's Group C, Group R, or Group M cases or all cases in general.

Group Cases	Comments/Feedback
R	
C	
M	
All Groups	

Figure A-3 cont'd. Freshness Survey Rating Form

Appendix B

MAPS Test Group “Good-to-Serve” Product Case Yield Process and Data Tables

This appendix expands on the process for calculating the “Good-to-Serve” product case yields summarized in Section 2.7.2 and provides the supporting data tables for each of the graphs in Chapter 3 that depict the “Good-to-Serve” case yield data (after case culling) for each product.

Due to the nature of fresh produce, gross case weights vary from week to week and each week also from case to case. Table B-1 clearly depicts this variation based on actual iceberg and romaine gross case weight data prior to Irvine, California container load out. For the Guam test, for each shipment all iceberg and all romaine cases were received as a single lot. To minimize potential overall differences between the cases assigned to each test group, the received product pallets were broken down case-by-case and sequentially assigned to each test group (M-C-R-M-C-R-M-C-R-etc). Thus for each weekly shipment, differences between the resulting test group case weights (minimum, maximum, average) are attributable to normal variability in case weights.

Due to these natural variations in actual gross case weight, the preferred method to quantify actual end-of-supply-chain “Good-to-Serve” case yields was as a percentage of the Irvine, California or start-of-supply-chain actual case product weights. This method removed the potential effect of different start-of-supply-chain case weights. For the MAPS test, this method was utilized for the iceberg and romaine test cases because required start-of-supply-chain and end-of-supply-chain gross case weights (e.g. case plus contents, no ice) for all test groups could both be readily obtained by simple case weighing. However, the start-of-supply-chain actual case product weights could not be calculated for the iced broccoli shipments.

For iceberg and romaine lettuce, the case yields (% case weight) were calculated based on the Irvine, California gross case weights, the Guam recorded post-culling gross “Good-to-Serve” case weights (shown in Table B-1), average fiberboard case weight, and the MAPS liner case weight. Based on a sample of actual cases, the average fiberboard case weight was 3.5 lb for iceberg and 3.3 lb for romaine, and the Group M MAPS case liner was an additional 0.3 lb. The Irvine, California Group C and Group R case weights were as received, and the Group M case weights were after repack into the MAPS case liner. Table B-2 is an example of the calculation of “Good-to-Serve” case yields for iceberg lettuce. The starting gross case weights and the culled gross case weights for both cases were simply assumed to be the same to show the difference between the Group C (or R) and Group M % case yield calculations.

As shown by Table B-1, for each item by test shipment, the average gross case weights across the three test groups were very similar and within 1-2 lb of each other despite larger between-case weight variations. For example, the difference between minimum and maximum case weights for iceberg for the three test shipments were 8.3 lb, 6.7 lb, and 13.0 lb, while for romaine they were 7.5 lb, 13.1 lb, and 7.0 lb. Also, for romaine the overall average case weight for each shipment was very similar at 35.2, 36.0, and 35.3 lb. However for iceberg, while the

average case weights for Test Shipments 1 and 2 were very similar at 51.7 and 51.4 lb, the Test Shipment 3 average weight was noticeably lower at 45.7 lb.

Table B-1. Starting Weekly Gross Case Weights for Lettuce (Irvine, California)

Test Shipment	Test Group	Gross Case Weights By Produce Item					
		Iceberg			Romaine		
		Min	Max	Ave	Min	Max	Ave
1	C	49.8	54.4	52.3	32.2	38.0	35.2
	M*	46.3	54.6	50.5	33.4	39.7	35.6
	R	48.0	54.0	52.2	32.9	37.8	34.8
	All	46.3	54.6	51.7	32.2	39.7	35.2
2	C	48.5	54.5	51.5	31.3	38.5	35.5
	M*	49.4	54.0	51.2	33.4	44.4	36.6
	R	48.7	55.2	51.4	33.7	39.0	35.9
	All	48.5	55.2	51.4	31.3	44.4	36.0
3	C	42.0	49.9	45.8	32.6	38.4	34.9
	M*	38.6	51.6	44.9	32.9	38.4	35.6
	R	42.3	50.4	46.5	32.8	39.6	35.4
	All	38.6	51.6	45.7	32.6	39.6	35.3

* To facilitate direct between group comparisons, excludes the extra weight of 0.3 pounds for MAPS case liner.

Table B-2. Example Calculation for “Good-to-Serve” Case Yields

Factor	Case Weight Data	Formula	Test Group	
			Group C (or R)	Group M
A	Starting Gross Case Weight - Irvine	----	50.0	50.0
B	Culled Gross Case Weight - Guam	----	40.0	40.0
C	Case Fiberboard Weight	----	3.5	3.5
D	Case MAPs Liner Weight	----	0.0	0.3
E	Culled Net Product Weight - Guam	=B-C-D	36.5	36.2
F	Starting Net Product Weight - Irvine	=A-C-D	46.5	46.2
% Case Yield		=E/F	78.5%	78.4%

For the Guam MAPS broccoli assessment, the overall plan was for DLA sourced iceless cases for Group M, and iced cases for Group C and Group R cases. As planned, all DLA Group M cases were iceless, all Group C cases were iced, and Shipment 1 and 2 Group R cases were iceless and only the Shipment 3 cases were iced. All DLA iced broccoli cases were ordered and received in Irvine, California as pre-iced cases. Therefore, for broccoli it was not possible to obtain comparable start of supply chain gross case weights (i.e. case plus product with no ice)

across all three test groups. For this reason, “Good-to-Serve” end of supply chain case yields for broccoli are presented as gross “Good-to-Serve” case weights rather than % case yield. For broccoli, this means between group differences may be partly attributable to differences in actual starting case weights, supply chain product evaporative losses, and/or actual discards as part of the end-of-supply-chain culling process.

Tables B-3, B-4, B-5, and B-6 are the data tables that support the graphs in Chapter 3 that depict the “Good-to-Serve” case yield data (after case culling) for iceberg lettuce, romaine lettuce, DLA broccoli, and Apio broccoli, respectively.

Table B-3. Iceberg Lettuce “Good-to-Serve” Case Yields (% Case Weight) by Data Set

Age Group	Test Shipment	Post Harvest Age	Test Group		
			Group C	Group M	Group R
1	1	23	73%	83%	82%
1	1	23	83%	76%	75%
1	1	24	77%	75%	83%
1	1	25	68%	76%	80%
Ave	1	23-25	75%	77%	80%
1	2	23	85%	92%	94%
1	2	24	84%	82%	79%
1	2	25	86%	87%	78%
Ave	2	23-25	85%	87%	84%
1	3	23	79%	77%	74%
1	3	24	69%	74%	68%
1	3	25	74%	68%	70%
Ave	3	23-25	74%	73%	71%
Ave	All	23-25	78%	79%	78%
2	1	28	61%	68%	66%
2	1	29	65%	60%	69%
Ave	1	28-29	63%	64%	68%
2	2	28	80%	80%	82%
2	2	29	79%	79%	83%
Ave	2	28-29	80%	79%	82%
2	3	28	65%	62%	46%
2	3	29	65%	62%	56%
Ave	3	28-29	65%	62%	51%
Ave	All	28-29	69%	69%	67%
3	1	31	53%	47%	58%
3	1	32	58%	29%	55%
Ave	1	31-32	55%	38%	57%

**Table B-3. Iceberg Lettuce “Good-to-Serve” Case Yields (% Case Weight) by Data Set–
Continued**

Age Group	Test Shipment	Post Harvest Age	Test Group		
			Group C	Group M	Group R
3	2	30	72%	86%	82%
3	2	31	68%	80%	69%
3	2	32	68%	45%	71%
Ave	2	30-32	69%	70%	74%
3	3	31	50%	54%	----
3	3	32	54%	44%	49%
Ave	3	31-32	52%	49%	49%
Ave	All	31-32	59%	52%	60%
4	1	35	45%	42%	37%
4	1	36	0%	52%	0%
Ave	1	35-36	23%	47%	19%
4	2	35	66%	61%	63%
4	2	36	61%	62%	55%
Ave	2	35-36	64%	61%	59%
4	3	35	28%	32%	30%
4	3	36	29%	8%	14%
Ave	3	35-36	28%	20%	22%
Ave	All	35-36	38%	43%	33%
5	1	38	51%	59%	51%
Ave	1	38	51%	59%	51%
5	2	39	53%	62%	42%
5	2	39	55%	68%	53%
Ave	2	39	54%	65%	48%
5	3	37	32%	33%	0%
5	3	38	0%	0%	0%
5	3	39	0%	51%	0%
Ave	3	37-39	11%	28%	0%
Ave	All	37-39	39%	51%	33%

Table B-4. Romaine Lettuce “Good-to-Serve” Case Yields (% Case Weight) by Data Set

Age Group	Test Shipment	Post Harvest Age	Test Group		
			Group C	Group M	Group R
1	1	23	88%	94%	90%
1	1	23	85%	94%	87%
1	1	24	75%	77%	66%
1	1	25	62%	68%	58%
Ave	1	23-25	78%	83%	75%
1	2	23	80%	79%	73%
1	2	24	57%	65%	58%
1	2	25	78%	79%	78%
Ave	2	23-25	72%	74%	70%
1	3	23	54%	54%	59%
1	3	24	51%	55%	59%
1	3	25	85%	76%	64%
Ave	3	23-25	63%	62%	61%
Ave	All	23-25	71%	73%	69%
2	1	28	54%	60%	60%
2	1	29	66%	67%	63%
Ave	1	28-29	60%	64%	61%
2	2	28	47%	50%	55%
2	2	29	42%	59%	38%
Ave	2	28-29	45%	54%	47%
2	3	28	47%	49%	50%
2	3	29	60%	53%	46%
Ave	3	28-29	53%	51%	48%
Ave	All	28-29	53%	56%	52%
3	1	31	47%	73%	39%
3	1	32	49%	54%	50%
Ave	1	31-32	48%	64%	45%

**Table B-4. Romaine Lettuce “Good-to-Serve” Case Yields (% Case Weight) by Data Set–
Continued**

Age Group	Test Shipment	Post Harvest Age	Test Group		
			Group C	Group M	Group R
3	2	30	73%	53%	50%
3	2	31	41%	49%	46%
3	2	32	41%	57%	50%
Ave	2	30-32	52%	53%	48%
3	3	31	33%	42%	40%
3	3	32	30%	62%	30%
Ave	3	31-32	31%	52%	35%
Ave	All	30-32	44%	56%	43%
4	1	35	24%	38%	33%
4	1	36	29%	21%	0%
Ave	1	35-36	26%	29%	16%
4	2	35	21%	35%	39%
4	2	36	24%	58%	23%
Ave	2	35-36	22%	47%	31%
4	3	35	27%	55%	27%
4	3	36	40%	59%	33%
Ave	3	35-36	33%	57%	30%
Ave	All	35-36	27%	44%	26%
5	1	38	27%	47%	18%
Ave	1	38	27%	47%	18%
5	2	39	0%	45%	24%
5	2	39	0%	36%	0%
Ave	2	39	0%	41%	12%
5	3	37	0%	60%	0%
5	3	38	16%	33%	13%
5	3	39	30%	54%	25%
Ave	3	37-39	15%	49%	13%
Ave	All	37-39	13%	44%	15%

Table B-5. DLA Broccoli “Good-to-Serve” Gross Case Weight (lb) by Data Set

Age Group	Test Shipment	Post Harvest Age	Test Group		
			Group C	Group M	Group R
1	1	23	26.5	22.9	---
1	1	23	26.2	23.6	20.0
1	1	24	23.9	23.3	22.9
1	1	25	24.0	22.5	22.2
Ave	1	23-25	25.2	23.1	21.7
1	2	23	23.6	21.6	19.4
1	2	24	22.2	23.4	21.0
1	2	25	23.2	21.9	18.0
Ave	2	23-25	23.0	22.3	19.4
1	3	23	0.0	20.1	22.0
1	3	24	20.2	23.4	17.9
1	3	25	20.7	23.7	18.3
Ave	3	23-25	13.6	22.4	19.4
Ave	All	23-25	20.6	22.6	20.2
2	1	28	23.7	22.3	21.5
2	1	29	23.4	22.3	19.1
Ave	1	28-29	23.5	22.3	20.3
2	2	28	21.5	22.6	20.4
2	2	29	18.9	22.5	18.1
Ave	2	28-29	20.2	22.5	19.3
2	3	28	20.0	21.5	18.1
2	3	29	19.8	22.5	17.7
Ave	3	28-29	19.9	22.0	17.9
Ave	All	28-89	21.2	22.3	19.2

**Table B-5. DLA Broccoli “Good-to-Serve” Gross Case Weight (lb) by Data Set -
Continued**

Age Group	Test Shipment	Post Harvest Age	Test Group		
			Group C	Group M	Group R
3	1	31	23.5	21.5	18.1
3	1	32	22.5	23.5	18.5
Ave	1	31-32	23.0	22.5	18.3
3	2	30	19.3	22.7	17.6
3	2	31	20.5	22.3	18.2
3	2	32	21.2	24.0	19.2
Ave	2	30-32	20.3	23.0	18.3
3	3	31	21.1	23.9	19.0
Ave	3	31	21.1	23.9	19.0
All	All	30-32	21.5	23.1	18.6
4	1	35	20.5	23.5	20.3
4	1	36	19.5	22.3	18.6
Ave	1	35-36	20.0	22.9	19.5
4	2	35	19.8	22.8	19.3
4	2	36	20.1	24.6	17.0
Ave	2	35-36	20.0	23.7	18.2
4	3	35	20.5	21.3	18.8
4	3	36	17.4	22.4	17.9
Ave	3	35-36	19.0	21.9	18.3
Ave	All	35-36	19.6	22.8	18.7
5	1	38	18.5	22.5	15.0
Ave	1	38	18.5	22.5	15.0
5	3	37	18.7	21.3	10.3
5	3	38	20.9	22.8	14.3
5	3	39	17.0	20.7	16.1
Ave	3	37-39	18.9	21.6	13.6
Ave	All	37-39	18.7	22.1	14.3

Table B-6. Apio Broccoli “Good-to-Serve” Gross Case Weight (lb) by Data Set

Age Group	Test Shipment	Post Harvest Age	Test Group		
			Group C	Group M	Group R
1	2	23	21.3	21.3	22.3
2	2	28	22.0	21.0	22.6
2	2	28	22.6	21.2	21.1
3	2	30	18.4	20.0	17.8
4	2	35	18.5	21.0	19.5
4	2	35	19.0	20.0	18.0
5	2	37	17.5	21.0	19.5
6	2	42	15.6	18.3	18.3
6	2	43	13.8	17.3	15.7
1	3	23	20.3	19.8	21.1
2	3	28	19.0	20.5	20.5
2	3	28	21.0	21.5	18.5
4	3	35	18.6	17.8	18.1
4	3	35	20.2	18.4	19.7
5	3	37	19.0	15.2	18.0
5	3	38	14.0	18.1	17.3
5	3	38	17.7	11.0	12.7
5	3	39	18.4	12.6	16.0
5	3	39	19.8	16.3	15.6

Appendix C

MAPS Test Group Freshness Ratings by Data Set

This appendix provides data tables and graphs detailing the results for the four freshness factors summarized in Chapter 3 for each product tested and the supporting data tables for each of the detailed overall freshness graphs provided in Chapter 3, as follows:

<u>Freshness Factor</u>	<u>Data Table</u>	<u>Data Graph</u>
<u>Iceberg Lettuce</u>		
External Appearance	Table C-1	Figure C-1
Internal Appearance	Table C-2	Figure C-2
Smell/Odor	Table C-3	Figure C-3
Crispness/Firmness/Springback	Table C-4	Figure C-4
<u>Romaine Lettuce</u>		
External Appearance	Table C-5	Figure C-5
Internal Appearance	Table C-6	Figure C-6
Smell/Odor	Table C-7	Figure C-7
Crispness/Firmness/Springback	Table C-8	Figure C-8
<u>DLA Broccoli</u>		
External Appearance	Table C-9	Figure C-9
Internal Appearance	Table C-10	Figure C-10
Smell/Odor	Table C-11	Figure C-11
Crispness/Firmness/Springback	Table C-12	Figure C-12
<u>Apio Broccoli</u>		
External Appearance	Table C-13	Figure C-13
Internal Appearance	Table C-14	Figure C-14
Smell/Odor	Table C-15	Figure C-15
Crispness/Firmness/Springback	Table C-16	Figure C-16

Overall Freshness Data Tables

<u>Product</u>	<u>Data Table</u>
Iceberg Lettuce	Table C-17
Romaine Lettuce	Table C-18
DLA Broccoli	Table C-19
Apio Broccoli	Table C-20

Table C-1. Iceberg Lettuce Average External Appearance Freshness Ratings

Test Shipment	Age Group	Post Harv			No Raters	Test Group		
		Facility	Date	Age		C	M	R
1	1	SPV	10/7	23	14	6.18	5.64	3.91
1	1	Mag	10/8	24	7	6.14	5.14	5.71
1	1	Cov	10/9	25	8	4.33	6.33	5.78
1	1	All	----	24	----	5.55	5.70	5.13
2	1	SPV	10/14	23	7	7.71	7.14	7.29
2	1	Mag	10/15	24	6	7.43	7.57	6.86
2	1	Cov	10/16	25	5	7.00	7.75	7.75
2	1	All	----	24	----	7.38	7.49	7.30
3	1	SPV	10/21	23	5	7.80	7.60	7.80
3	1	Mag	10/22	24	6	6.33	7.00	6.17
3	1	Cov	10/23	25	6	7.00	6.40	6.20
3	1	All	----	24	----	7.04	7.00	6.72
All	1	All	----	24	----	6.66	6.73	6.38
1	2	Mag	10/12	28	7	3.29	3.57	3.57
1	2	Cov	10/13	29	7	3.88	3.75	4.88
1	2	All	----	29	----	3.58	3.66	4.22
2	2	Mag	10/19	28	6	6.67	6.83	6.83
2	2	Cov	10/20	29	5	6.20	5.60	6.00
2	2	All	----	29	----	6.43	6.22	6.42
3	2	Mag	10/26	28	5	5.40	5.40	2.80
3	2	Cov	10/27	29	5	5.60	4.80	4.20
3	2	All	----	29	----	5.50	5.10	3.50
All	2	All	----	29	----	5.17	4.99	4.71
1	3	Mag	10/15	31	7	3.14	3.86	3.14
1	3	Cov	10/16	32	6	2.83	3.67	3.50
1	3	All	----	32	----	2.99	3.76	3.32
2	3	SPV	10/21	30	3	4.75	7.50	6.50
2	3	Mag	10/22	31	4	5.75	6.50	4.75
2	3	Cov	10/23	32	6	4.80	5.40	5.80
2	3	All	----	31	----	5.10	6.47	5.68
3	3	Mag	10/29	31	5	4.80	5.40	
3	3	Cov	10/30	32	3	4.25	2.75	3.75
3	3	All	----	32	----	4.53	4.08	3.75
All	3	All	----	32	----	4.20	4.77	4.25

Table C-1. Iceberg Lettuce Average External Appearance Freshness Ratings—Continued

Test Shipment	Age Group	Facility	Date	Post Harv Age	No Raters	Test Group		
						C	M	R
1	4	Mag	10/19	35	6	2.33	3.17	1.50
1	4	Cov	10/20	36	7	2.86	4.43	2.00
1	4	All	----	36	----	2.60	3.80	1.75
2	4	Mag	10/26	35	5	4.60	4.00	4.60
2	4	Cov	10/27	36	5	3.50	5.25	4.75
2	4	All	----	36	----	4.05	4.63	4.68
3	4	Mag	11/2	35	5	1.40	1.60	1.60
3	4	Cov	11/3	36	4	1.50	1.75	1.50
3	4	All	----	36	----	1.45	1.68	1.55
All	4	All	----	36	----	1.93	3.37	2.66
1	5	SPV	10/22	38	2	1.00	3.50	4.00
1	5	All	----	38	----	1.00	3.50	4.00
2	5	Mag	10/29	38	5	2.60	4.40	3.20
2	5	Cov	10/30	39	3	2.67	4.33	4.67
2	5	All	----	39	----	2.63	4.37	3.93
3	5	SPV	11/4	37	3	1.33	2.00	1.33
3	5	Mag	11/5	38	4	1.00	1.25	1.25
3	5	Cov	11/6	39	4	2.00	3.25	1.00
3	5	All	----	38	----	1.44	2.17	1.19
All	5	All	----	38	----	1.69	3.34	3.04

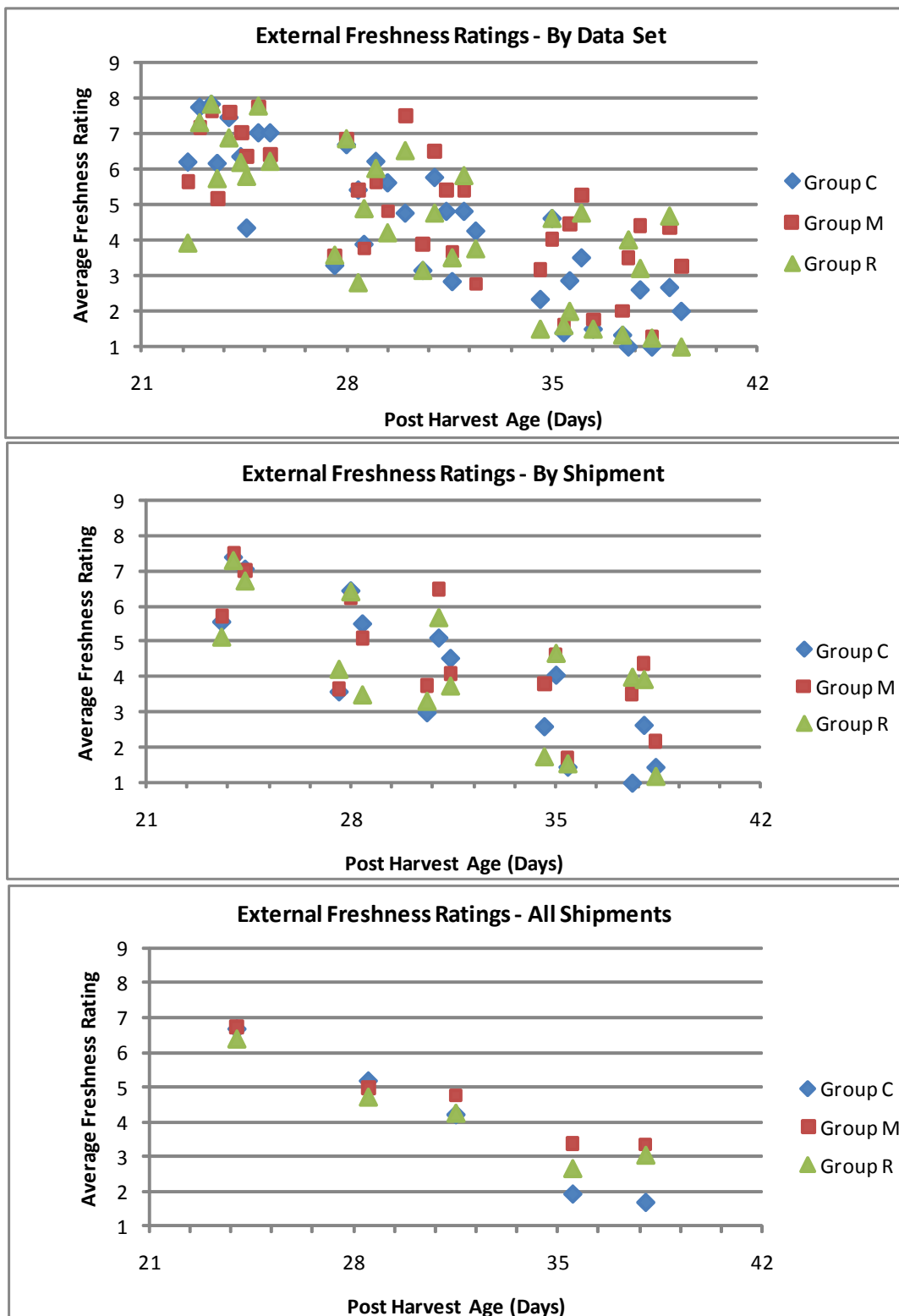


Figure C-1. Iceberg Lettuce External Freshness Ratings

Table C-2. Iceberg Lettuce Average Internal Appearance Freshness Ratings

Test Shipment	Age Group	Post Harv				Test Group		
		Facility	Date	Age	No Raters	C	M	R
1	1	SPV	10/7	23	14	6.82	6.73	6.18
1	1	Mag	10/8	24	7	7.00	6.43	7.14
1	1	Cov	10/9	25	8	5.78	6.78	6.56
1	1	All	----	24	----	6.53	6.64	6.63
2	1	SPV	10/14	23	7	7.71	8.00	7.57
2	1	Mag	10/15	24	6	7.86	7.57	7.14
2	1	Cov	10/16	25	5	7.75	5.50	8.00
2	1	All	----	24	----	7.77	7.02	7.57
3	1	SPV	10/21	23	5	8.20	7.60	8.20
3	1	Mag	10/22	24	6	6.83	7.33	8.00
3	1	Cov	10/23	25	6	8.20	7.60	7.60
3	1	All	----	24	----	7.74	7.51	7.93
All	1	All	----	24	----	7.35	7.06	7.38
1	2	Mag	10/12	28	7	3.86	3.57	4.00
1	2	Cov	10/13	29	7	5.13	5.00	6.63
1	2	All	----	29	----	4.49	4.29	5.31
2	2	Mag	10/19	28	6	6.67	7.17	7.17
2	2	Cov	10/20	29	5	7.40	5.00	6.80
2	2	All	----	29	----	7.03	6.08	6.98
3	2	Mag	10/26	28	5	7.00	7.00	6.60
3	2	Cov	10/27	29	5	7.00	4.40	5.60
3	2	All	----	29	----	7.00	5.70	6.10
All	2	All	----	29	----	6.17	5.36	6.13
1	3	Mag	10/15	31	7	4.00	3.57	5.14
1	3	Cov	10/16	32	6	4.50	4.00	5.17
1	3	All	----	32	----	4.25	3.79	5.15
2	3	SPV	10/21	30	3	6.50	7.25	7.00
2	3	Mag	10/22	31	4	6.50	5.75	6.75
2	3	Cov	10/23	32	6	6.40	3.20	6.00
2	3	All	----	31	----	6.47	5.40	6.58
3	3	Mag	10/29	31	5	6.40	4.80	
3	3	Cov	10/30	32	3	6.00	3.50	5.00
3	3	All	----	32	----	6.20	4.15	5.00
All	3	All	----	32	----	5.64	4.45	5.58

Table C-2. Iceberg Lettuce Average Internal Appearance Freshness Ratings--Continued

Test Shipment	Age Group	Facility	Date	Post Harv Age	No Raters	Test Group		
						C	M	R
1	4	Mag	10/19	35	6	5.33	4.17	4.67
1	4	Cov	10/20	36	7	3.86	5.43	3.29
1	4	All	----	36	----	4.60	4.80	3.98
2	4	Mag	10/26	35	5	6.00	5.60	5.00
2	4	Cov	10/27	36	5	5.00	5.25	5.00
2	4	All	----	36	----	5.50	5.43	5.00
3	4	Mag	11/2	35	5	3.60	3.20	3.00
3	4	Cov	11/3	36	4	3.50	5.00	3.00
3	4	All	----	36	----	3.55	4.10	3.00
All	4	All	----	36	----	4.38	4.77	3.99
1	5	SPV	10/22	38	2	2.00	5.50	5.00
1	5	All	----	38	----	2.00	5.50	5.00
2	5	Mag	10/29	38	5	5.40	4.40	4.80
2	5	Cov	10/30	39	3	3.00	3.67	5.67
2	5	All	----	39	----	4.20	4.03	5.23
3	5	SPV	11/4	37	3	3.33	2.67	2.33
3	5	Mag	11/5	38	4	1.50	2.50	2.25
3	5	Cov	11/6	39	4	2.25	3.50	1.25
3	5	All	----	38	----	2.36	2.89	1.94
All	5	All	----	38	----	2.85	4.14	4.06

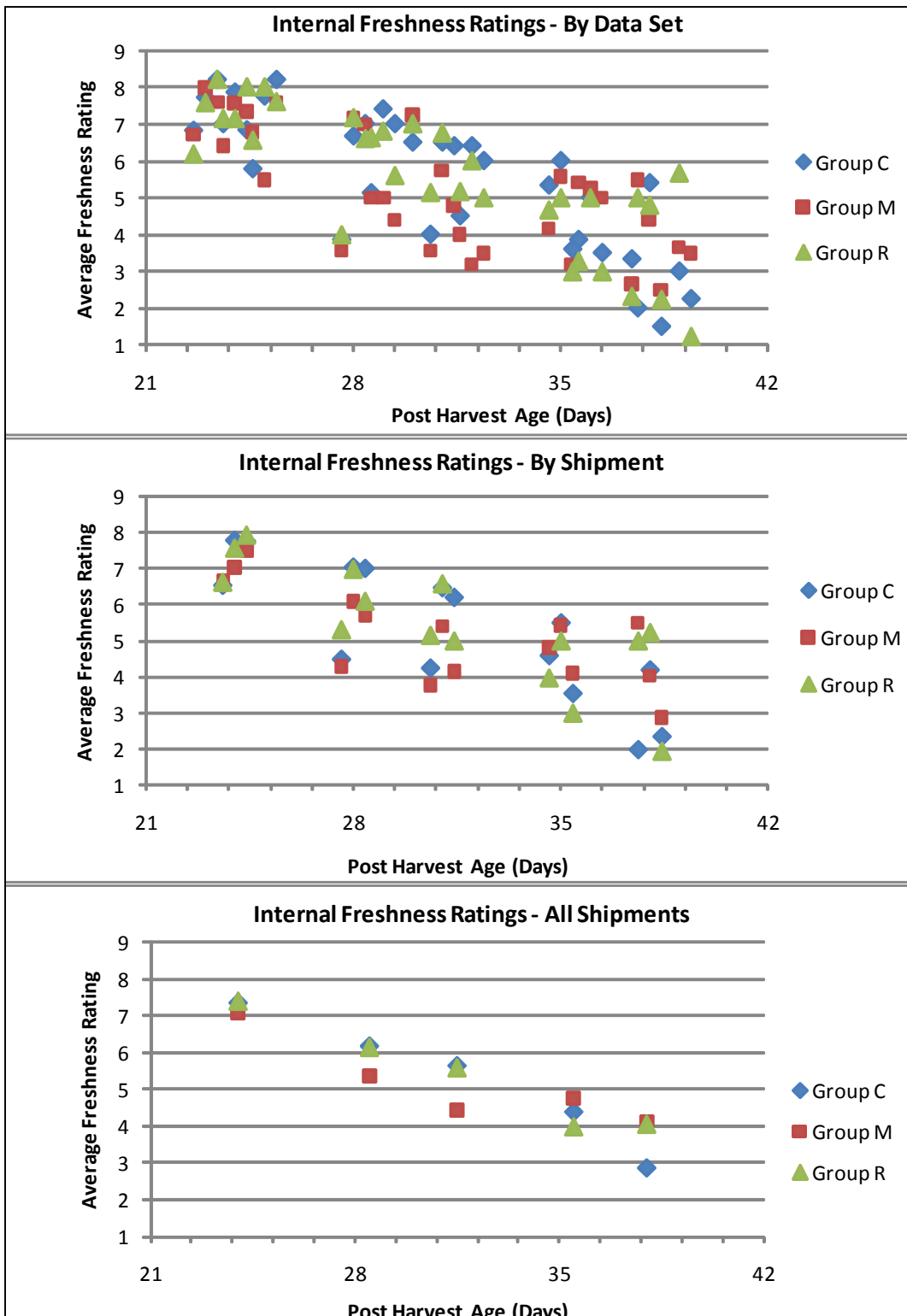


Figure C-2. Iceberg Lettuce Internal Freshness Ratings

Table C-3. Iceberg Lettuce Average Smell/Odor Freshness Ratings

Test Shipment	Age Group	Post Harv				Test Group		
		Facility	Date	Age	No Raters	C	M	R
1	1	SPV	10/7	23	14	6.64	5.64	5.18
1	1	Mag	10/8	24	7	6.14	5.86	6.71
1	1	Cov	10/9	25	8	5.67	6.89	6.44
1	1	All	----	24	----	6.15	6.13	6.11
2	1	SPV	10/14	23	7	7.43	8.00	7.43
2	1	Mag	10/15	24	6	7.67	7.33	7.50
2	1	Cov	10/16	25	5	7.25	6.75	7.25
2	1	All	----	24	----	7.45	7.36	7.39
3	1	SPV	10/21	23	5	8.00	8.00	8.00
3	1	Mag	10/22	24	6	6.67	6.83	6.67
3	1	Cov	10/23	25	6	7.80	7.40	7.40
3	1	All	----	24	----	7.49	7.41	7.36
All	1	All	----	24	----	7.03	6.97	6.95
1	2	Mag	10/12	28	7	3.57	3.71	4.29
1	2	Cov	10/13	29	7	5.25	4.63	5.75
1	2	All	----	29	----	4.41	4.17	5.02
2	2	Mag	10/19	28	6	7.17	7.17	7.17
2	2	Cov	10/20	29	5	6.80	5.80	6.60
2	2	All	----	29	----	6.98	6.48	6.88
3	2	Mag	10/26	28	5	6.80	6.80	6.00
3	2	Cov	10/27	29	5	6.40	5.80	5.40
3	2	All	----	29	----	6.60	6.30	5.70
All	2	All	----	29	----	6.00	5.65	5.87
1	3	Mag	10/15	31	7	3.67	3.67	3.83
1	3	Cov	10/16	32	6	3.83	4.17	5.00
1	3	All	----	32	----	3.75	3.92	4.42
2	3	SPV	10/21	30	3	5.75	7.50	7.00
2	3	Mag	10/22	31	4	5.25	6.25	5.75
2	3	Cov	10/23	32	6	6.60	6.20	6.80
2	3	All	----	31	----	5.87	6.65	6.52
3	3	Mag	10/29	31	5	5.80	5.80	
3	3	Cov	10/30	32	3	5.25	3.50	4.50
3	3	All	----	32	----	5.53	4.65	4.50
All	3	All	----	32	----	5.05	5.07	5.14

Table C-3. Iceberg Lettuce Average Smell/Odor Freshness Ratings--Continued

Test Shipment	Age Group	Post Harv				Test Group		
		Facility	Date	Age	No Raters	C	M	R
1	4	Mag	10/19	35	6	4.00	3.83	3.50
1	4	Cov	10/20	36	7	4.00	4.86	2.43
1	4	All	----	36	----	4.00	4.35	2.96
2	4	Mag	10/26	35	5	5.40	5.40	6.20
2	4	Cov	10/27	36	5	3.75	5.50	4.75
2	4	All	----	36	----	4.58	5.45	5.48
3	4	Mag	11/2	35	5	3.40	3.40	2.80
3	4	Cov	11/3	36	4	3.00	3.75	2.75
3	4	All	----	36	----	3.20	3.58	2.78
All	4	All	----	36	----	3.65	4.46	3.74
1	5	SPV	10/22	38	2	2.00	5.50	4.50
1	5	All	----	38	----	2.00	5.50	4.50
2	5	Mag	10/29	38	5	4.40	5.00	5.00
2	5	Cov	10/30	39	3	2.67	4.00	4.67
2	5	All	----	39	----	3.53	4.50	4.83
3	5	SPV	11/4	37	3	2.67	3.67	2.00
3	5	Mag	11/5	38	4	1.75	2.00	2.00
3	5	Cov	11/6	39	4	2.75	4.50	1.25
3	5	All	----	38	----	2.39	3.39	1.75
All	5	All	----	38	----	2.64	4.46	3.69

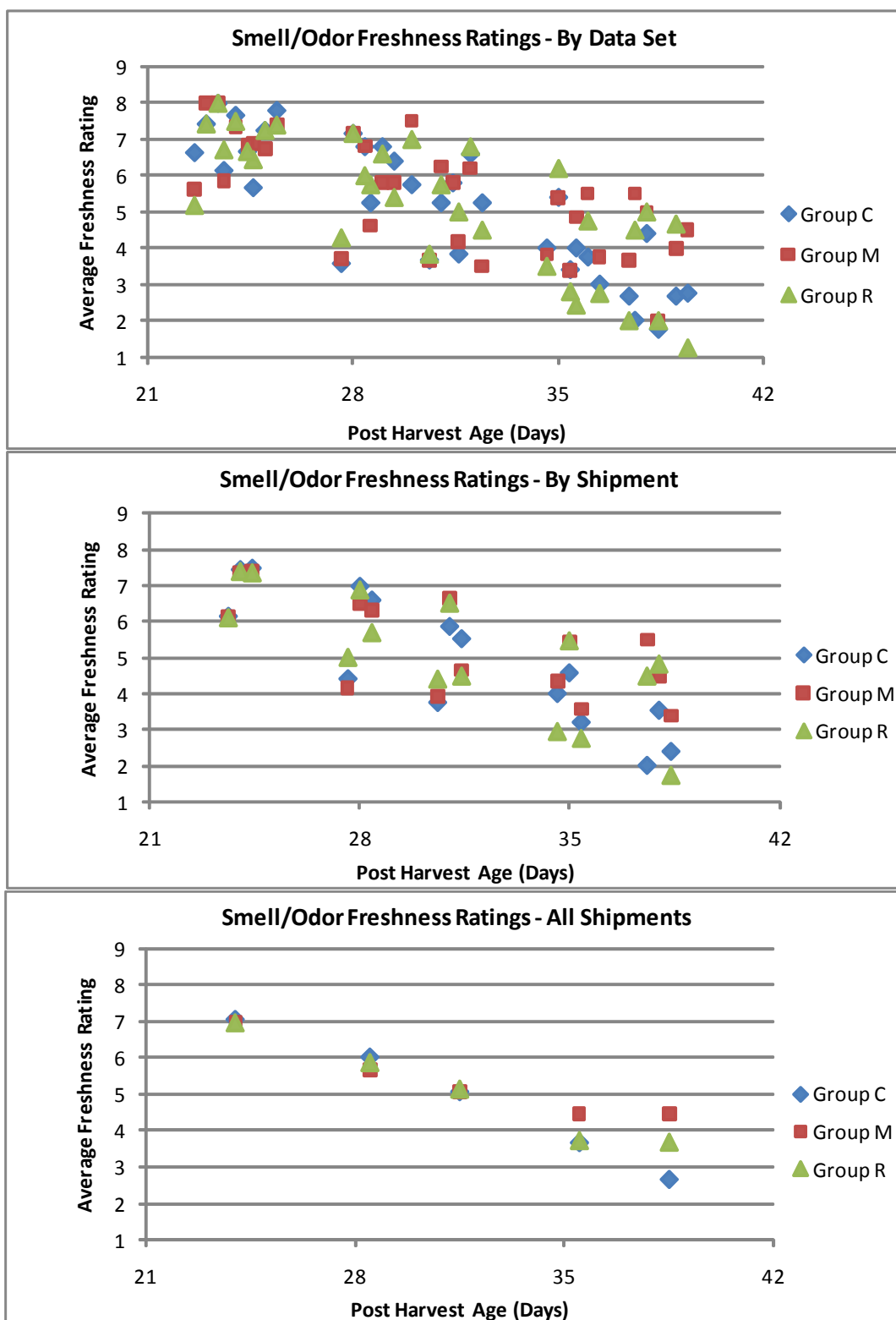


Figure C-3. Iceberg Lettuce Smell/Odor Freshness Ratings

Table C-4. Iceberg Lettuce Average Crispness/Firmness/Springback Freshness Ratings

Test Shipment	Age Group	Post Harv			No Raters	Test Group		
		Facility	Date	Age		C	M	R
1	1	SPV	10/7	23	14	6.64	6.27	5.09
1	1	Mag	10/8	24	7	6.86	6.86	6.57
1	1	Cov	10/9	25	8	6.33	7.00	6.67
1	1	All		24	----	6.61	6.71	6.11
2	1	SPV	10/14	23	7	7.57	8.00	7.14
2	1	Mag	10/15	24	6	7.86	7.43	7.57
2	1	Cov	10/16	25	5	7.50	7.50	8.25
2	1	All	----	24	----	7.64	7.64	7.65
3	1	SPV	10/21	23	5	8.00	8.20	8.00
3	1	Mag	10/22	24	6	7.50	7.50	7.50
3	1	Cov	10/23	25	6	8.00	7.60	7.80
3	1	All	----	24	----	7.83	7.77	7.77
All	1	All	----	24	----	7.36	7.37	7.18
1	2	Mag	10/12	28	7	4.29	4.14	5.29
1	2	Cov	10/13	29	7	5.75	5.75	6.38
1	2	All	----	29	----	5.02	4.95	5.83
2	2	Mag	10/19	28	6	7.00	7.17	6.83
2	2	Cov	10/20	29	5	7.60	6.60	6.60
2	2	All	----	29	----	7.30	6.88	6.72
3	2	Mag	10/26	28	5	7.60	7.60	7.00
3	2	Cov	10/27	29	5	7.00	6.40	6.20
3	2	All	----	29	----	7.30	7.00	6.60
All	2	All	----	29	----	6.54	6.28	6.38
1	3	Mag	10/15	31	7	5.14	5.00	5.43
1	3	Cov	10/16	32	6	4.33	4.83	5.17
1	3	All	----	32	----	4.74	4.92	5.30
2	3	SPV	10/21	30	3	6.75	7.50	6.75
2	3	Mag	10/22	31	4	6.75	6.75	6.50
2	3	Cov	10/23	32	6	6.60	5.80	7.40
2	3	All	----	31	----	6.70	6.68	6.88
3	3	Mag	10/29	31	5	6.40	6.40	
3	3	Cov	10/30	32	3	5.75	5.25	5.50
3	3	All	----	32	----	6.08	5.83	5.50
All	3	All	----	32	----	5.84	5.81	5.89

**Table C-4. Iceberg Lettuce Average Crispness/Firmness/Springback Freshness Ratings–
Continued**

Test	Age	Post Harv				Test Group		
Shipment	Group	Facility	Date	Age	No Raters	C	M	R
1	4	Mag	10/19	35	6	5.17	5.00	4.33
1	4	Cov	10/20	36	7	4.43	5.71	3.29
1	4	All	----	36	----	4.80	5.36	3.81
2	4	Mag	10/26	35	5	5.40	5.80	5.60
2	4	Cov	10/27	36	5	5.25	6.50	5.75
2	4	All	----	36	----	5.33	6.15	5.68
3	4	Mag	11/2	35	5	4.20	4.20	3.40
3	4	Cov	11/3	36	4	4.25	4.50	3.00
3	4	All	----	36	----	4.23	4.35	3.20
All	4	All	----	36	----	4.76	5.29	4.23
1	5	SPV	10/22	38	2	1.00	6.00	5.00
1	5	All	----	38	----	1.00	6.00	5.00
2	5	Mag	10/29	38	5	6.20	6.00	5.80
2	5	Cov	10/30	39	3	3.00	4.33	4.67
2	5	All	----	39	----	4.60	5.17	5.23
3	5	SPV	11/4	37	3	3.67	4.00	4.00
3	5	Mag	11/5	38	4	3.00	3.50	3.25
3	5	Cov	11/6	39	4	3.75	5.50	1.50
3	5	All	----	38	----	3.47	4.33	2.92
All	5	All	----	38	----	3.02	5.17	4.38

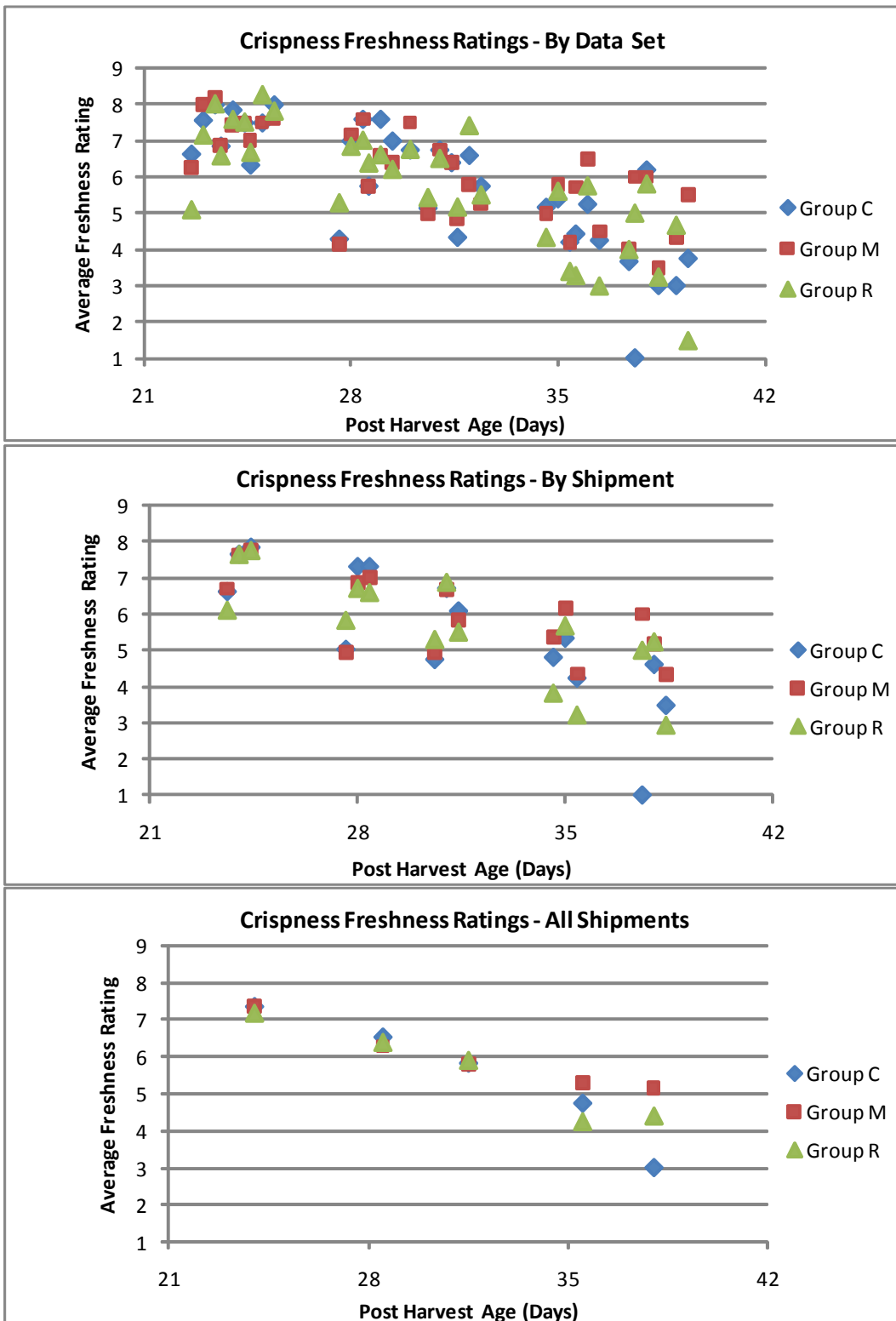


Figure C-4. Iceberg Lettuce Crispness/Firmness/Springback Freshness Ratings

Table C-5. Romaine Lettuce Average External Appearance Freshness Ratings

Test Shipment	Age Group	Post Harv			No Raters	Test Group		
		Facility	Date	Age		C	M	R
1	1	SPV	10/7	23	14	7.70	7.80	7.70
1	1	Mag	10/8	24	7	6.00	7.14	5.43
1	1	Cov	10/9	25	8	7.00	6.63	5.38
1	1	All	----	24	----	6.90	7.19	6.17
2	1	SPV	10/14	23	7	7.57	7.43	7.43
2	1	Mag	10/15	24	6	6.50	7.38	7.00
2	1	Cov	10/16	25	5	7.80	8.00	7.80
2	1	All	----	24	----	7.29	7.60	7.41
3	1	SPV	10/21	23	5	8.20	8.80	8.20
3	1	Mag	10/22	24	6	7.67	7.50	7.83
3	1	Cov	10/23	25	6	8.00	8.50	7.50
3	1	All	----	24	----	7.96	8.27	7.84
All	1	All	----	24	----	7.38	7.69	7.14
1	2	Mag	10/12	28	7	5.57	6.86	6.71
1	2	Cov	10/13	29	7	7.13	6.38	6.50
1	2	All	----	28.5	----	6.35	6.62	6.61
2	2	Mag	10/19	28	6	7.33	6.67	5.67
2	2	Cov	10/20	29	5	3.60	6.60	6.40
2	2	All	----	28.5	----	5.47	6.63	6.03
3	2	Mag	10/26	28	5	6.60	8.00	6.60
3	2	Cov	10/27	29	5	5.60	5.80	5.40
3	2	All	----	28.5	----	6.10	6.90	6.00
All	2	All	----	28.5	----	5.97	6.72	6.21
1	3	Mag	10/15	31	7	3.86	6.29	3.29
1	3	Cov	10/16	32	6	4.00	3.60	3.40
1	3	All	----	31.5	----	3.93	4.94	3.34
2	3	SPV	10/21	30	3	6.25	7.25	6.25
2	3	Mag	10/22	31	4	5.00	7.25	6.00
2	3	Cov	10/23	32	6	3.20	6.80	5.80
2	3	All	----	31	----	4.82	7.10	6.02
3	3	Mag	10/29	31	5	5.40	7.00	4.60
3	3	Cov	10/30	32	3	6.25	6.50	4.75
3	3	All	----	31.5	----	5.83	6.75	4.68
All	3	All	----	31.5	----	4.86	6.26	4.68

Table C-5. Romaine Lettuce Average External Appearance Freshness Ratings–Continued

Test Shipment	Age Group	Facility	Date	Age	No. Raters	Test Group		
						C	M	R
1	4	Mag	10/19	35	6	3.50	5.67	4.00
1	4	Cov	10/20	36	7	4.86	4.00	1.00
1	4	All	----	35.5	----	4.18	4.83	2.50
2	4	Mag	10/26	35	5	2.20	4.80	5.00
2	4	Cov	10/27	36	5	2.80	6.80	2.80
2	4	All	----	35.5	----	2.50	5.80	3.90
3	4	Mag	11/2	35	5	2.80	5.40	2.00
3	4	Cov	11/3	36	4	4.25	5.50	3.75
3	4	All	----	35.5	----	3.53	5.45	2.88
All	4	All	----	35.5	----	3.40	5.36	3.09
1	5	SPV	10/22	38	2	4.50	5.50	2.50
1	5	All	----	38	----	4.50	5.50	2.50
2	5	Mag	10/29	38	5	2.40	5.80	2.00
2	5	Cov	10/30	39	3	4.33	6.00	4.00
2	5	All	----	38.5	----	3.37	5.90	3.00
3	5	SPV	11/4	37	3	5.33	6.33	3.33
3	5	Mag	11/5	38	4	1.25	2.25	1.75
3	5	Cov	11/6	39	4	2.75	5.75	2.50
3	5	All	----	38	----	3.11	4.78	2.53
All	5	All	----	38	----	3.66	5.39	2.68

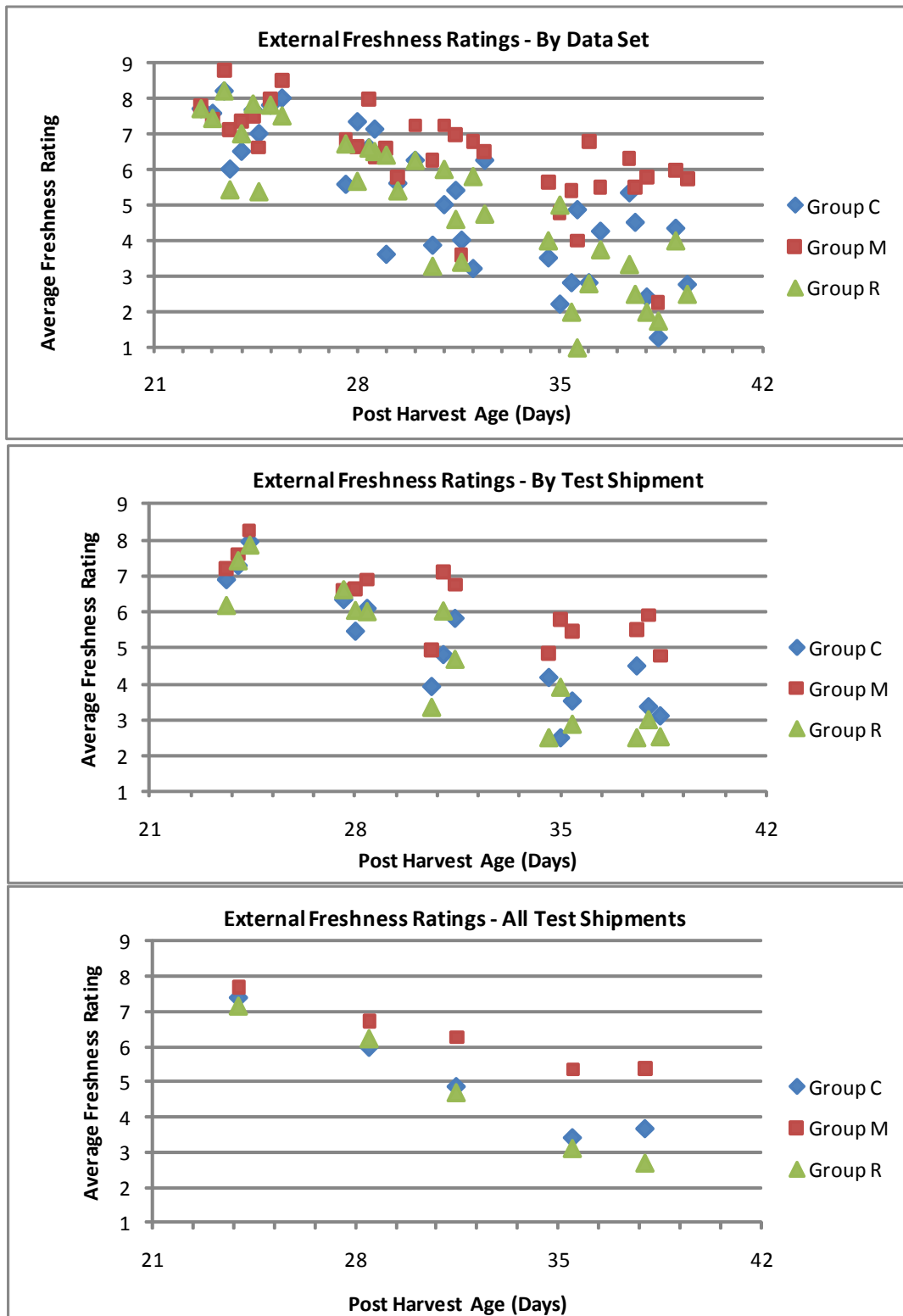


Figure C-5. Romaine Lettuce External Freshness Ratings

Figure C-6. Romaine Lettuce Internal Freshness Ratings

Test Shipment	Age Group	Facility	Date	Age	No Raters	Test Group		
						C	M	R
1	1	SPV	10/7	23	14	7.90	8.00	7.90
1	1	Mag	10/8	24	7	7.14	7.57	6.00
1	1	Cov	10/9	25	8	7.50	7.00	6.13
1	1	All	----	24	----	7.51	7.52	6.68
2	1	SPV	10/14	23	7	7.86	7.86	7.86
2	1	Mag	10/15	24	6	7.25	7.50	7.13
2	1	Cov	10/16	25	5	8.40	8.40	8.20
2	1	All	----	24	----	7.84	7.92	7.73
3	1	SPV	10/21	23	5	8.40	8.80	8.40
3	1	Mag	10/22	24	6	8.00	8.17	8.00
3	1	Cov	10/23	25	6	8.25	8.50	7.75
3	1	All	----	24	----	8.22	8.49	8.05
All	1	All	----	24	----	7.86	7.98	7.48
1	2	Mag	10/12	28	7	6.71	7.14	7.00
1	2	Cov	10/13	29	7	7.63	7.25	7.38
1	2	All	----	28.5	----	7.17	7.20	7.19
2	2	Mag	10/19	28	6	6.33	7.67	6.67
2	2	Cov	10/20	29	5	5.20	7.20	7.20
2	2	All	----	28.5	----	5.77	7.43	6.93
3	2	Mag	10/26	28	5	7.00	7.40	7.20
3	2	Cov	10/27	29	5	7.20	7.20	6.40
3	2	All	----	28.5	----	7.10	7.30	6.80
All	2	All	----	28.5	----	6.68	7.31	6.97
1	3	Mag	10/15	31	7	4.43	6.86	4.00
1	3	Cov	10/16	32	6	5.80	5.60	5.00
1	3	All	----	31.5	----	5.11	6.23	4.50
2	3	SPV	10/21	30	3	6.50	6.75	6.75
2	3	Mag	10/22	31	4	6.00	7.00	7.00
2	3	Cov	10/23	32	6	3.40	6.80	6.20
2	3	All	----	31	----	5.30	6.85	6.65
3	3	Mag	10/29	31	5	6.00	7.60	5.00
3	3	Cov	10/30	32	3	6.25	7.00	5.50
3	3	All	----	31.5	----	6.13	7.30	5.25
All	3	All	----	31.5	----	5.51	6.79	5.47

Table C-6. Romaine Lettuce Average Internal Appearance Freshness Ratings—Continued

Test Shipment	Age Group	Facility	Date	Age	No. Raters	Test Group		
						C	M	R
1	4	Mag	10/19	35	6	5.33	6.17	5.83
1	4	Cov	10/20	36	7	5.71	5.57	1.00
1	4	All	----	35.5	----	5.52	5.87	3.42
2	4	Mag	10/26	35	5	4.20	6.00	5.80
2	4	Cov	10/27	36	5	5.00	7.00	5.20
2	4	All	----	35.5	----	4.60	6.50	5.50
3	4	Mag	11/2	35	5	5.20	5.80	4.00
3	4	Cov	11/3	36	4	6.75	7.00	7.00
3	4	All	----	35.5	----	5.98	6.40	5.50
All	4	All	----	35.5	----	5.37	6.26	4.81
1	5	SPV	10/22	38	2	5.50	6.00	3.00
1	5	All	----	38	----	5.50	6.00	3.00
2	5	Mag	10/29	38	5	4.60	6.80	5.00
2	5	Cov	10/30	39	3	5.00	6.00	4.33
2	5	All	----	38.5	----	4.80	6.40	4.67
3	5	SPV	11/4	37	3	7.00	6.67	5.33
3	5	Mag	11/5	38	4	3.75	4.25	4.00
3	5	Cov	11/6	39	4	4.00	6.00	3.25
3	5	All	----	38	----	4.92	5.64	4.19
All	5	All	----	38	----	5.07	6.01	3.95

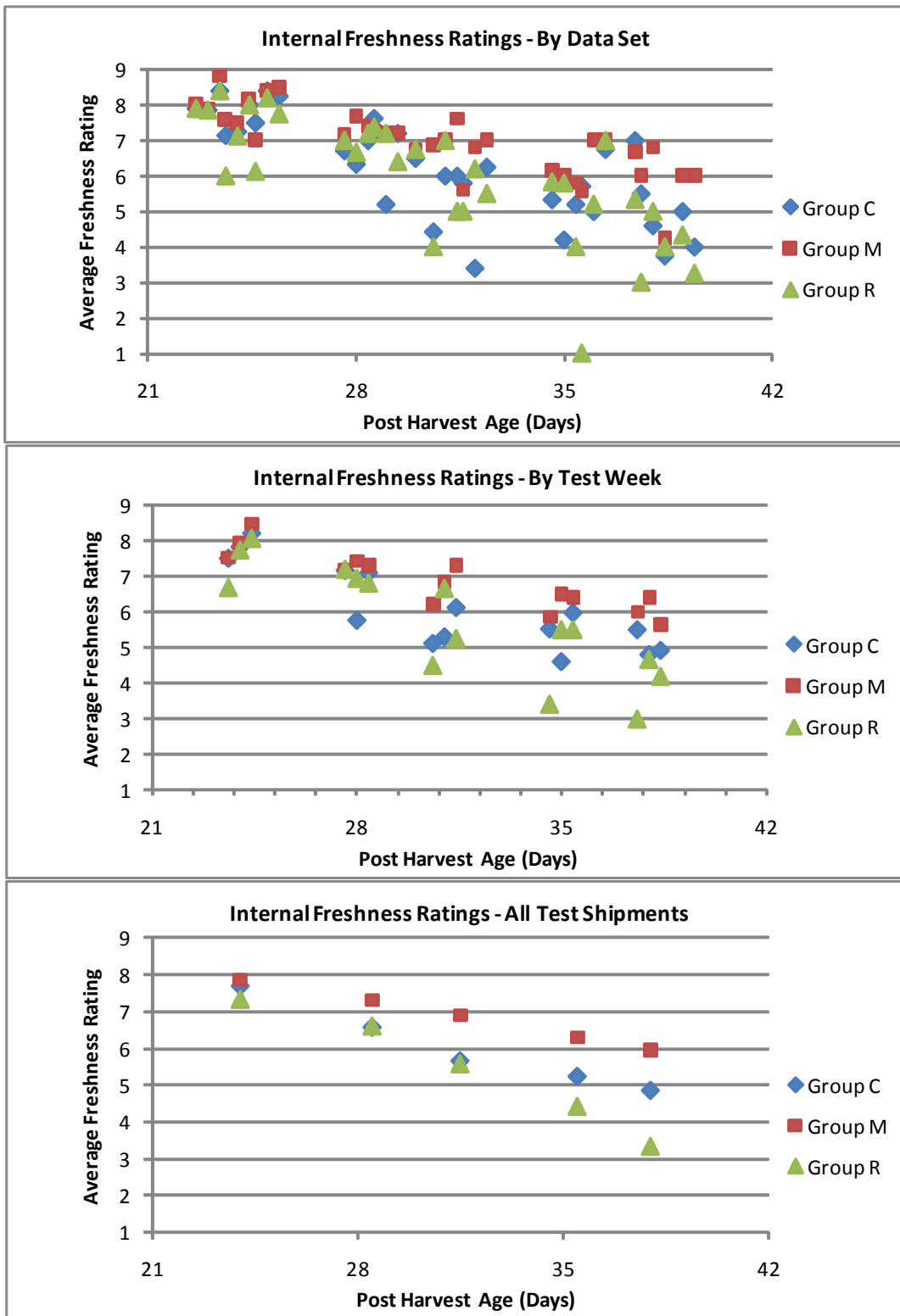


Figure C-6. Romaine Lettuce Internal Freshness Ratings

Table C-7. Romaine Lettuce Average Smell/Odor Freshness Ratings

Test Shipment	Age Group	Facility	Date	Age	No Raters	Test Group		
						C	M	R
1	1	SPV	10/7	23	14	7.70	7.80	8.00
1	1	Mag	10/8	24	7	7.00	6.71	6.29
1	1	Cov	10/9	25	8	7.13	7.13	6.38
1	1	All	----	24	----	7.28	7.21	6.89
2	1	SPV	10/14	23	7	7.14	7.14	7.14
2	1	Mag	10/15	24	6	7.14	7.14	7.00
2	1	Cov	10/16	25	5	8.00	8.00	7.80
2	1	All	----	24	----	7.43	7.43	7.31
3	1	SPV	10/21	23	5	8.00	8.40	7.80
3	1	Mag	10/22	24	6	7.83	7.67	7.67
3	1	Cov	10/23	25	6	7.75	8.00	7.50
3	1	All	----	24	----	7.86	8.02	7.66
All	1	All	----	24	----	7.52	7.55	7.29
1	2	Mag	10/12	28	7	6.29	7.33	6.71
1	2	Cov	10/13	29	7	7.13	6.50	6.38
1	2	All	----	28.5	----	6.71	6.92	6.54
2	2	Mag	10/19	28	6	6.67	6.83	6.33
2	2	Cov	10/20	29	5	4.00	6.80	6.80
2	2	All	----	28.5	----	5.33	6.82	6.57
3	2	Mag	10/26	28	5	7.40	7.80	7.00
3	2	Cov	10/27	29	5	7.20	7.00	6.80
3	2	All	----	28.5	----	7.30	7.40	6.90
All	2	All	----	28.5	----	6.45	7.04	6.67
1	3	Mag	10/15	31	7	5.00	6.57	4.86
1	3	Cov	10/16	32	6	6.00	5.60	4.20
1	3	All	----	31.5	----	5.50	6.09	4.53
2	3	SPV	10/21	30	3	6.50	7.00	6.50
2	3	Mag	10/22	31	4	5.25	6.75	6.50
2	3	Cov	10/23	32	6	4.00	7.20	6.60
2	3	All	----	31	----	5.25	6.98	6.53
3	3	Mag	10/29	31	5	6.40	7.00	5.80
3	3	Cov	10/30	32	3	6.00	6.50	5.75
3	3	All	----	31.5	----	6.20	6.75	5.78
All	3	All	----	31.5	----	5.65	6.61	5.61

Table C-7. Romaine Lettuce Average Smell/Odor Freshness Ratings–Continued

Test Shipment	Age Group	Facility	Date	Age	No. Raters	Test Group		
						C	M	R
1	4	Mag	10/19	35	6	5.33	6.17	5.17
1	4	Cov	10/20	36	7	5.57	4.86	1.00
1	4	All	----	35.5	----	5.45	5.51	3.08
2	4	Mag	10/26	35	5	3.40	6.20	5.80
2	4	Cov	10/27	36	5	4.20	6.60	4.00
2	4	All	----	35.5	----	3.80	6.40	4.90
3	4	Mag	11/2	35	5	4.80	5.80	3.80
3	4	Cov	11/3	36	4	6.00	6.50	6.00
3	4	All	----	35.5	----	5.40	6.15	4.90
All	4	All	----	35.5	----	4.88	6.02	4.29
1	5	SPV	10/22	38	2	5.50	6.50	2.00
1	5	All	----	38	----	5.50	6.50	2.00
2	5	Mag	10/29	38	5	4.00	6.20	3.80
2	5	Cov	10/30	39	3	4.00	5.00	4.00
2	5	All	----	38.5	----	4.00	5.60	3.90
3	5	SPV	11/4	37	3	6.67	7.00	5.33
3	5	Mag	11/5	38	4	4.00	4.00	4.00
3	5	Cov	11/6	39	4	5.00	6.00	3.00
3	5	All	----	38	----	5.22	5.67	4.11
All	5	All	----	38	----	4.91	5.92	3.34

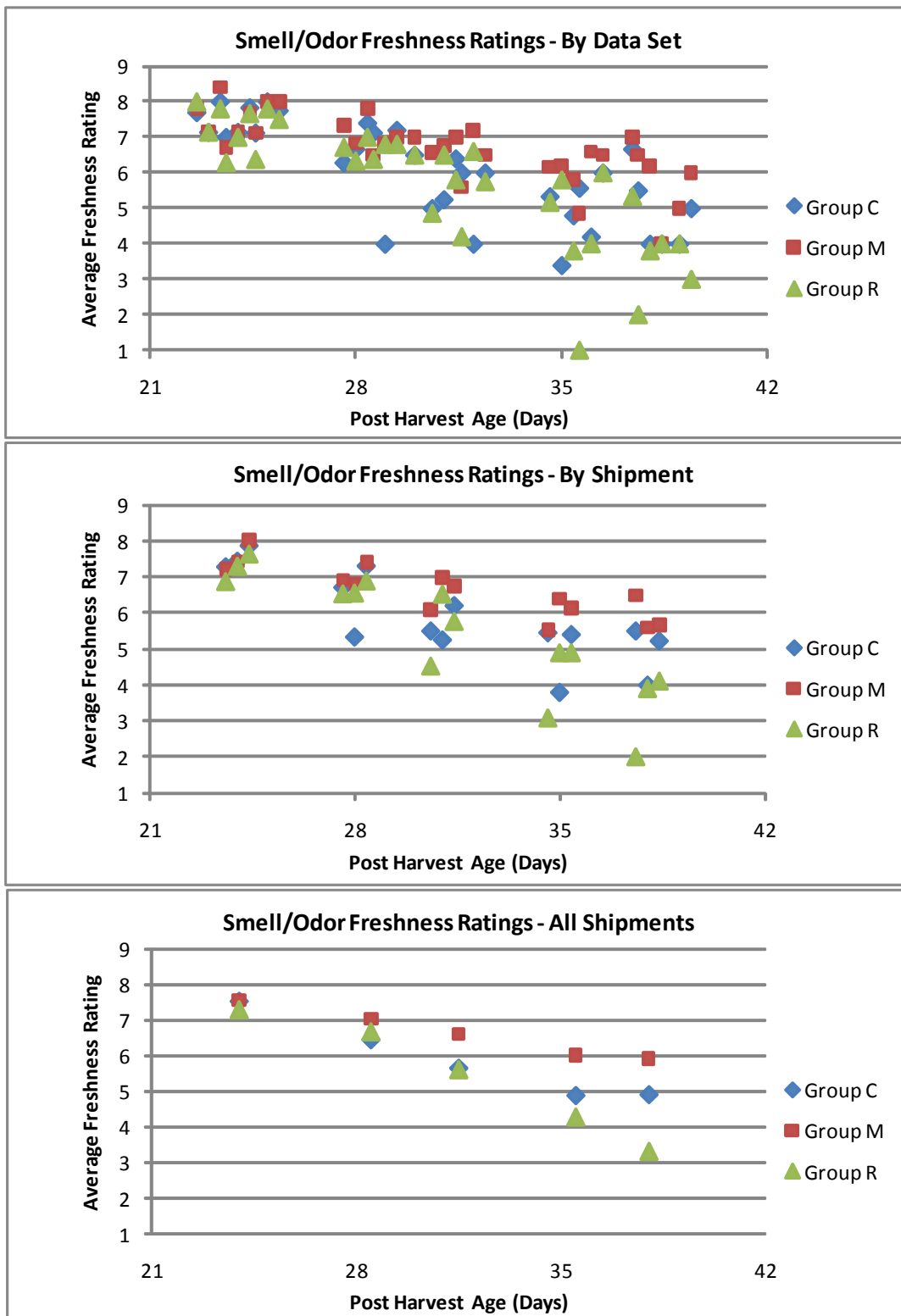


Figure C-7. Romaine Lettuce Smell/Odor Freshness Ratings

Table C-8. Romaine Lettuce Average Crispness/Firmness/Springback Freshness Ratings

Test Shipment	Age Group	Facility	Date	Age	No Raters	Test Group		
						C	M	R
1	1	SPV	10/7	23	14	7.80	8.00	7.60
1	1	Mag	10/8	24	7	7.00	7.43	6.00
1	1	Cov	10/9	25	8	7.38	7.38	6.50
1	1	All	----	24	----	7.39	7.60	6.70
2	1	SPV	10/14	23	7	7.71	7.57	7.29
2	1	Mag	10/15	24	6	7.25	7.50	7.00
2	1	Cov	10/16	25	5	8.40	8.40	8.40
2	1	All	----	24	----	7.79	7.82	7.56
3	1	SPV	10/21	23	5	8.20	8.80	7.80
3	1	Mag	10/22	24	6	8.17	8.00	8.00
3	1	Cov	10/23	25	6	8.00	8.50	8.00
3	1	All	----	24	----	8.12	8.43	7.93
All	1	All	----	24	----	7.77	7.95	7.40
1	2	Mag	10/12	28	7	6.00	7.71	6.29
1	2	Cov	10/13	29	7	7.25	7.13	6.50
1	2	All	----	28.5	----	6.63	7.42	6.39
2	2	Mag	10/19	28	6	7.33	7.33	7.00
2	2	Cov	10/20	29	5	4.80	7.20	6.40
2	2	All	----	28.5	----	6.07	7.27	6.70
3	2	Mag	10/26	28	5	7.80	8.00	8.00
3	2	Cov	10/27	29	5	7.40	7.20	7.20
3	2	All	----	28.5	----	7.60	7.60	7.60
All	2	All	----	28.5	----	6.76	7.43	6.90
1	3	Mag	10/15	31	7	5.00	7.14	5.00
1	3	Cov	10/16	32	6	6.40	6.60	5.40
1	3	All	----	31.5	----	5.70	6.87	5.20
2	3	SPV	10/21	30	3	6.75	7.00	6.50
2	3	Mag	10/22	31	4	7.00	7.50	7.00
2	3	Cov	10/23	32	6	5.20	7.40	7.00
2	3	All	----	31	----	6.32	7.30	6.83
3	3	Mag	10/29	31	5	6.60	7.60	6.00
3	3	Cov	10/30	32	3	6.75	6.75	6.50
3	3	All	----	31.5	----	6.68	7.18	6.25
All	3	All	----	31.5	----	6.23	7.12	6.09

**Table C-8. Romaine Lettuce Average Crispness/Firmness/Springback Freshness Ratings–
Continued**

Test	Age					Test Group		
Shipment	Group	Facility	Date	Age	No. Raters	C	M	R
1	4	Mag	10/19	35	6	5.83	7.00	6.00
1	4	Cov	10/20	36	7	6.14	5.86	1.00
1	4	All	----	35.5	----	5.99	6.43	3.50
2	4	Mag	10/26	35	5	5.00	6.60	5.80
2	4	Cov	10/27	36	5	5.40	7.00	5.60
2	4	All	----	35.5	----	5.20	6.80	5.70
3	4	Mag	11/2	35	5	6.20	6.40	3.40
3	4	Cov	11/3	36	4	7.00	7.25	7.00
3	4	All	----	35.5	----	6.60	6.83	5.20
All	4	All	----	35.5	----	5.93	6.68	4.80
1	5	SPV	10/22	38	2	6.00	6.00	2.00
1	5	All	----	38	----	6.00	6.00	2.00
2	5	Mag	10/29	38	5	5.40	6.80	5.60
2	5	Cov	10/30	39	3	5.33	6.00	5.00
2	5	All	----	38.5	----	5.37	6.40	5.30
3	5	SPV	11/4	37	3	7.33	7.00	6.67
3	5	Mag	11/5	38	4	4.50	5.25	4.50
3	5	Cov	11/6	39	4	5.25	7.25	4.25
3	5	All	----	38	----	5.69	6.50	5.14
All	5	All	----	38	----	5.69	6.30	4.15

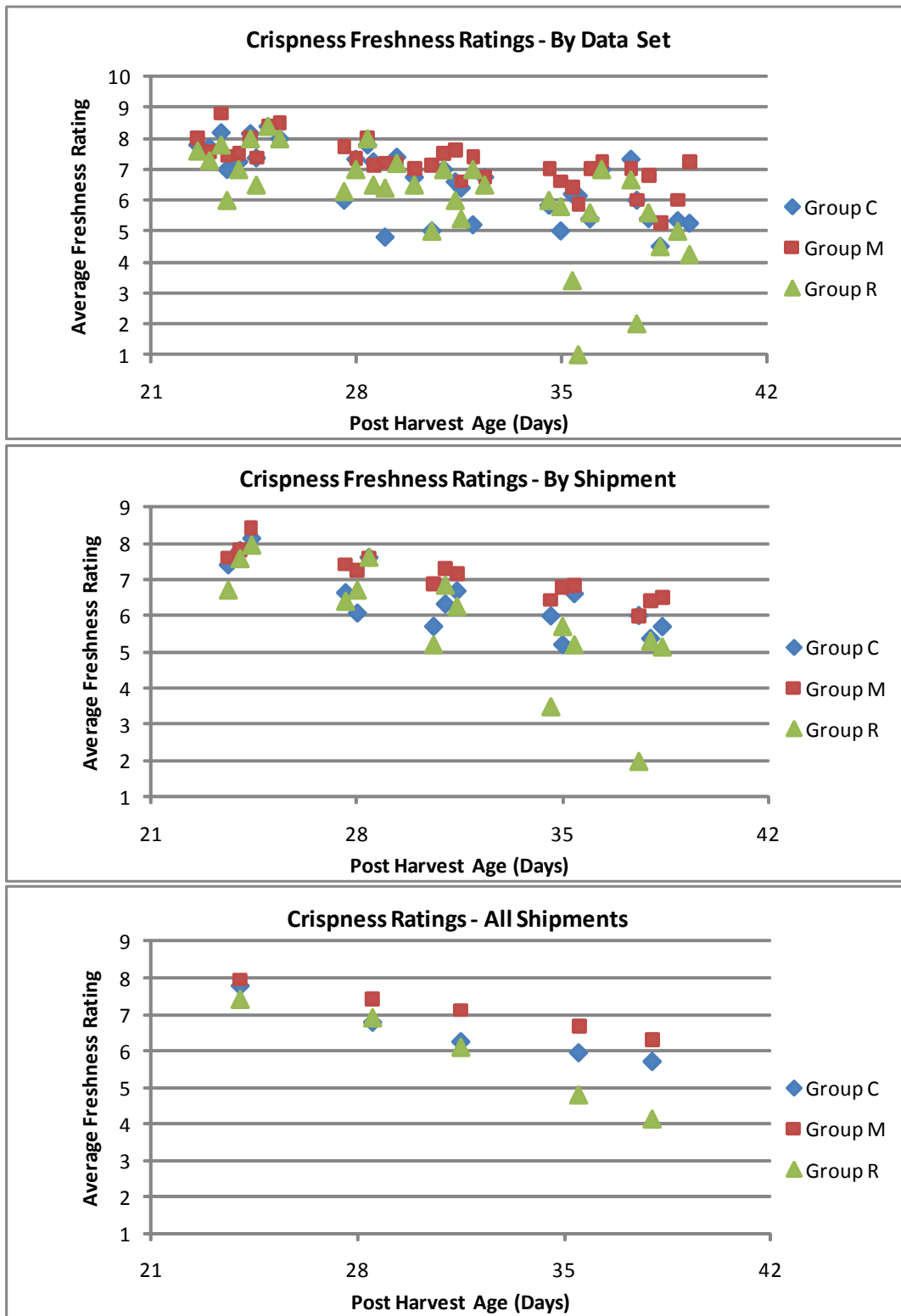


Figure C-8. Romaine Lettuce Crispness/Firmness/Springback Freshness Ratings

Table C-9. DLA Broccoli Average External Appearance Freshness Ratings

Test Shipment	Age Group	Post Harv			No. Raters	Test Group		
		Facility	Date	Age		C	M	R
1	1	SPV	10/7	23	14	8.36	8.71	8.08
1	1	Mag	10/8	24	7	6.57	6.86	5.71
1	1	Cov	10/9	25	8	7.75	8.00	7.00
1	1	All	----	24	----	7.56	7.86	6.93
2	1	SPV	10/14	23	7	7.43	7.57	6.57
2	1	Mag	10/15	24	6	6.83	6.83	6.67
2	1	Cov	10/16	25	5	8.60	8.40	7.60
2	1	All	----	24	----	7.62	7.60	6.95
3	1	SPV	10/21	23	5	8.20	8.60	2.60
3	1	Mag	10/22	24	6	7.83	8.00	5.83
3	1	Cov	10/23	25	6	7.50	8.67	5.17
3	1	All	----	24	----	7.84	8.42	4.53
All	1	All	----	24	----	7.67	7.96	6.14
1	2	Mag	10/12	28	7	6.43	7.00	5.86
1	2	Cov	10/13	29	7	6.43	7.71	5.57
1	2	All	----	29	----	6.43	7.36	5.71
2	2	Mag	10/19	28	6	7.17	7.50	6.50
2	2	Cov	10/20	29	5	6.80	8.00	6.40
2	2	All	----	29	----	6.98	7.75	6.45
3	2	Mag	10/26	28	5	8.40	7.20	7.20
3	2	Cov	10/27	29	5	7.60	8.00	7.40
3	2	All	----	29	----	8.00	7.60	7.30
All	2	All	----	29	----	7.14	7.57	6.49
1	3	Mag	10/15	31	7	6.00	7.14	5.71
1	3	Cov	10/16	32	6	7.17	8.17	6.83
1	3	All	----	32	----	6.58	7.65	6.27
2	3	SPV	10/21	30	3	7.33	8.00	5.67
2	3	Mag	10/22	31	4	7.25	7.25	5.50
2	3	Cov	10/23	32	6	6.33	8.33	5.50
2	3	All	----	31	----	6.97	7.86	5.56
3	3	Mag	10/29	31	5	6.40	8.00	6.20
3	3	Cov	10/30	32	3	8.00	8.33	7.00
3	3	All	----	32	----	7.20	8.17	6.60
All	3	All	----	32	----	6.92	7.89	6.14

Table C-9. DLA Broccoli Average External Appearance Freshness Ratings--Continued

Test Shipment	Age Group	Facility	Date	Post Harv Age	No. Raters	Test Group		
						C	M	R
1	4	Mag	10/19	35	6	6.00	7.67	5.67
1	4	Cov	10/20	36	7	5.00	7.57	6.00
1	4	All	----	36	----	5.50	7.62	5.83
2	4	Mag	10/26	35	5	6.20	7.60	5.60
2	4	Cov	10/27	36	5	6.60	8.00	4.80
2	4	All	----	36	----	6.40	7.80	5.20
3	4	Mag	11/2	35	5	7.00	7.20	6.00
3	4	Cov	11/3	36	4	5.50	7.00	6.00
3	4	All	----	36	----	6.25	7.10	6.00
All	4	All	----	36	----	6.05	7.51	5.68
1	5	SPV	10/22	38	2	6.00	8.00	4.00
1	5	All	----	38	----	6.00	8.00	4.00
3	5	SPV	11/4	37	3	6.67	8.33	2.33
3	5	Mag	11/4	37	4	5.25	6.00	3.00
3	5	Cov	11/6	39	4	6.00	6.50	4.25
3	5	All	----	38	----	5.97	6.94	3.19
All	5	All	----	38	----	5.99	7.47	3.60

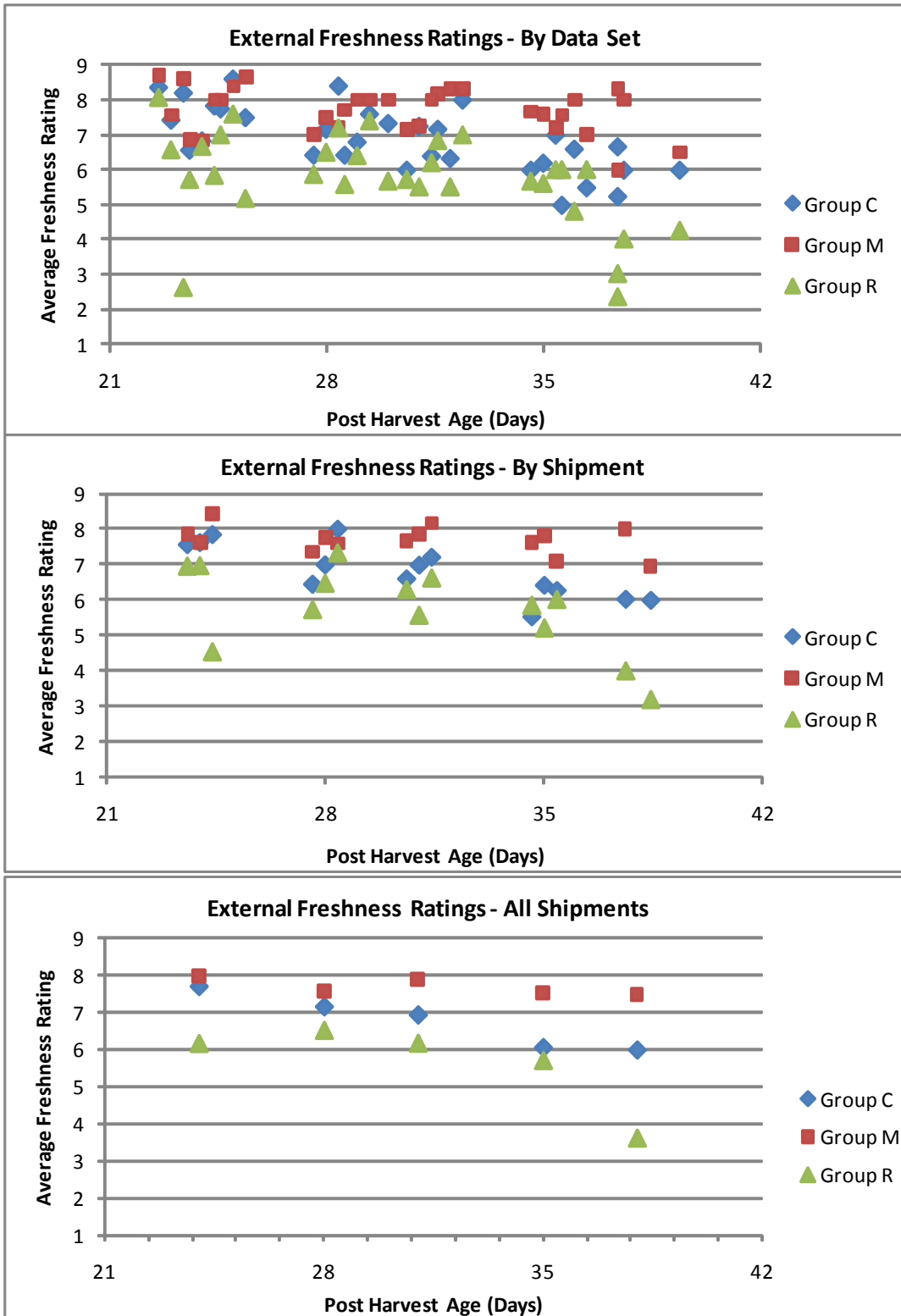


Figure C-9. DLA Broccoli External Freshness Ratings

Table C-10. DLA Broccoli Average Internal Appearance Freshness Ratings

Test Shipment	Age Group	Post Harv			No. Raters	Test Group		
		Facility	Date	Age		C	M	R
1	1	SPV	10/7	23	14	8.29	8.64	7.85
1	1	Mag	10/8	24	7	6.86	7.43	5.00
1	1	Cov	10/9	25	8	7.38	7.88	7.00
1	1	All	----	24	----	7.51	7.98	6.62
2	1	SPV	10/14	23	7	6.43	7.57	6.14
2	1	Mag	10/15	24	6	6.83	7.00	6.50
2	1	Cov	10/16	25	5	8.60	8.40	7.20
2	1	All	----	24	----	7.29	7.66	6.61
3	1	SPV	10/21	23	5	7.80	8.00	2.80
3	1	Mag	10/22	24	6	7.33	7.67	6.00
3	1	Cov	10/23	25	6	7.33	8.33	4.67
3	1	All	----	24	----	7.49	8.00	4.49
All	1	All	----	24	----	7.43	7.88	5.91
1	2	Mag	10/12	28	7	6.86	7.14	6.71
1	2	Cov	10/13	29	7	6.86	7.71	6.29
1	2	All	----	29	----	6.86	7.43	6.50
2	2	Mag	10/19	28	6	7.17	7.83	6.33
2	2	Cov	10/20	29	5	7.00	8.00	6.20
2	2	All	----	29	----	7.08	7.92	6.27
3	2	Mag	10/26	28	5	8.00	8.00	6.00
3	2	Cov	10/27	29	5	7.60	8.20	7.20
3	2	All	----	29	----	7.80	8.10	6.60
All	2	All	----	29	----	7.25	7.82	6.46
1	3	Mag	10/15	31	7	6.57	7.14	5.29
1	3	Cov	10/16	32	6	7.33	8.00	6.50
1	3	All	----	32	----	6.95	7.57	5.89
2	3	SPV	10/21	30	3	7.00	8.00	5.33
2	3	Mag	10/22	31	4	6.75	7.25	5.75
2	3	Cov	10/23	32	6	6.50	8.50	5.83
2	3	All	----	31	----	6.75	7.92	5.64
3	3	Mag	10/29	31	5	7.20	8.20	5.80
3	3	Cov	10/30	32	3	8.33	8.33	6.67
3	3	All	----	32	----	7.77	8.27	6.23
All	3	All	----	32	----	7.16	7.92	5.92

Table C-10. DLA Broccoli Average Internal Appearance Freshness Ratings–Continued

Test Shipment	Age Group	Post Harv				No. Raters	Test Group		
		Facility	Date	Age	C		M	R	
1	4	Mag	10/19	35	6	6.50	8.00	6.17	
1	4	Cov	10/20	36	7	5.29	7.57	6.00	
1	4	All	----	36	----	5.89	7.79	6.08	
2	4	Mag	10/26	35	5	6.80	7.80	6.00	
2	4	Cov	10/27	36	5	6.00	8.00	4.00	
2	4	All	----	36	----	6.40	7.90	5.00	
3	4	Mag	11/2	35	5	6.60	6.60	6.40	
3	4	Cov	11/3	36	4	6.50	7.25	6.75	
3	4	All	----	36	----	6.55	6.93	6.58	
All	4	All	----	36	----	6.28	7.54	5.89	
1	5	SPV	10/22	38	2	6.00	8.00	5.00	
1	5	All	----	38	----	6.00	8.00	5.00	
3	5	SPV	11/4	37	3	7.67	8.33	3.67	
3	5	Mag	11/4	37	4	5.75	6.00	3.75	
3	5	Cov	11/6	39	4	7.25	7.50	4.75	
3	5	All	----	38	----	6.89	7.28	4.06	
All	5	All	----	38	----	6.44	7.64	4.53	

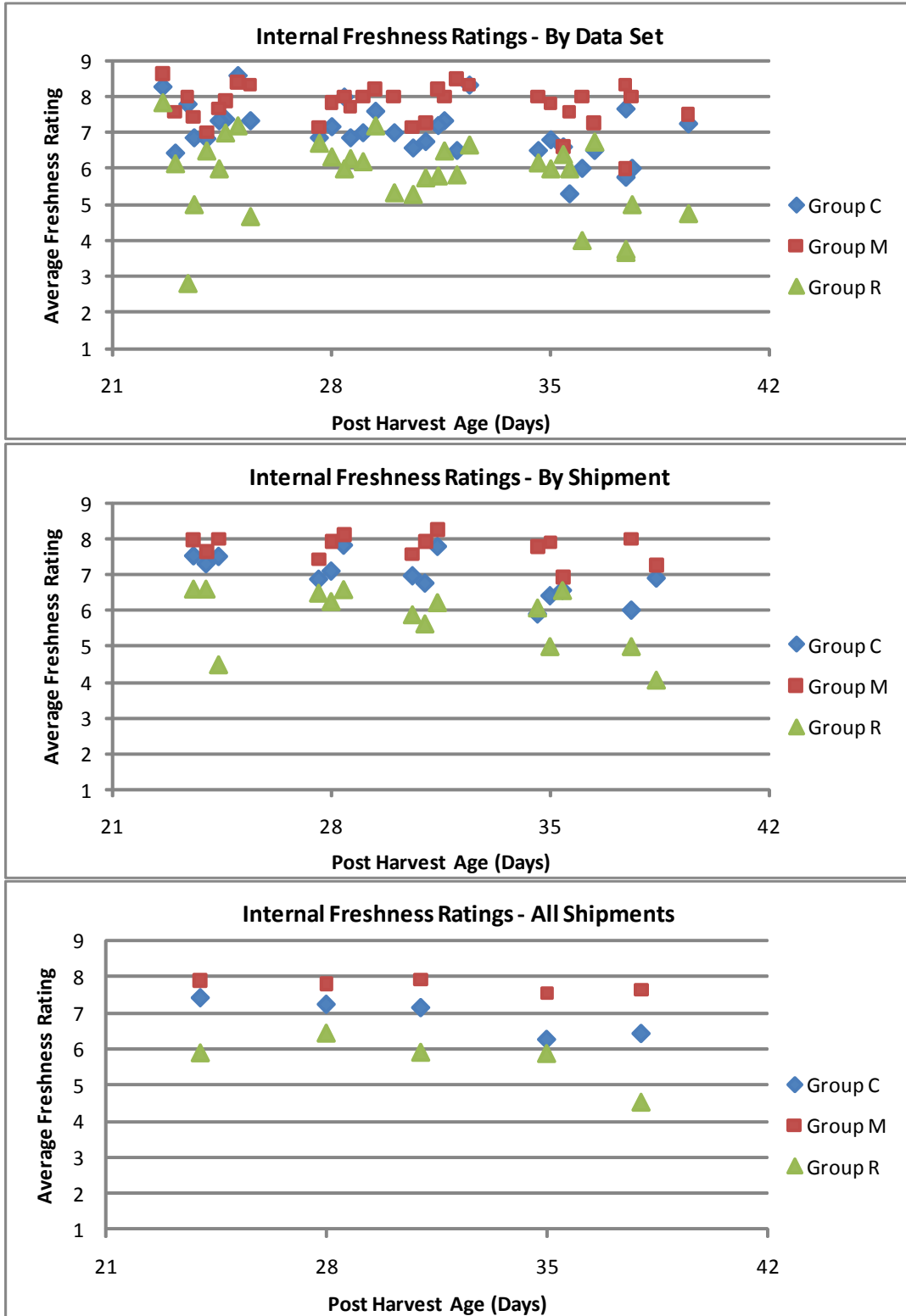


Figure C-10. DLA Broccoli Internal Freshness Ratings

Table C-11. DLA Broccoli Average Smell/Odor Freshness Ratings

Test Week	Data Set	Post Harv			No. Raters	Test Group		
		Facility	Date	Age		C	M	R
1	1	SPV	10/7	23	14	8.00	8.57	7.46
1	1	Mag	10/8	24	7	6.29	6.57	6.43
1	1	Cov	10/9	25	8	7.38	7.50	7.25
1	1	All	----	24	----	7.22	7.55	7.05
2	1	SPV	10/14	23	7	7.43	7.57	6.57
2	1	Mag	10/15	24	6	7.33	6.83	7.00
2	1	Cov	10/16	25	5	8.40	8.20	6.60
2	1	All	----	24	----	7.72	7.53	6.72
3	1	SPV	10/21	23	5	7.80	8.20	3.60
3	1	Mag	10/22	24	6	7.17	7.50	6.17
3	1	Cov	10/23	25	6	7.00	8.00	5.17
3	1	All	----	24	----	7.32	7.90	4.98
All	1	All	----	24	----	7.42	7.66	6.25
1	2	Mag	10/12	28	7	7.00	7.00	6.57
1	2	Cov	10/13	29	7	6.71	7.29	6.14
1	2	All	----	29	----	6.86	7.14	6.36
2	2	Mag	10/19	28	6	6.83	7.00	6.00
2	2	Cov	10/20	29	5	6.80	7.60	6.20
2	2	All	----	29	----	6.82	7.30	6.10
3	2	Mag	10/26	28	5	8.20	8.25	6.40
3	2	Cov	10/27	29	5	7.60	8.20	7.00
3	2	All	----	29	----	7.90	8.23	6.70
All	2	All	----	29	----	7.19	7.56	6.39
1	3	Mag	10/15	31	7	6.17	7.00	5.00
1	3	Cov	10/16	32	6	7.33	7.67	5.83
1	3	All	----	32	----	6.75	7.33	5.42
2	3	SPV	10/21	30	3	6.67	6.33	5.33
2	3	Mag	10/22	31	4	6.50	7.00	5.50
2	3	Cov	10/23	32	6	6.50	7.83	5.83
2	3	All	----	31	----	6.56	7.06	5.56
3	3	Mag	10/29	31	5	6.60	7.40	6.20
3	3	Cov	10/30	32	3	7.00	7.67	6.33
3	3	All	----	32	----	6.80	7.53	6.27
All	3	All	----	32	----	6.70	7.31	5.75

Table C-11. DLA Broccoli Average Smell/Odor Freshness Ratings–Continued

Test Shipment	Age Group	Post Harv			No. Raters	Test Group		
		Facility	Date	Age		C	M	R
1	4	Mag	10/19	35	6	6.17	7.50	5.33
1	4	Cov	10/20	36	7	6.00	7.43	6.00
1	4	All	----	36	----	6.08	7.46	5.67
2	4	Mag	10/26	35	5	6.60	7.80	5.80
2	4	Cov	10/27	36	5	6.60	7.80	4.40
2	4	All	----	36	----	6.60	7.80	5.10
3	4	Mag	11/2	35	5	7.00	7.00	6.60
3	4	Cov	11/3	36	4	6.00	7.75	6.50
3	4	All	----	36	----	6.50	7.38	6.55
All	4	All	----	36	----	6.39	7.55	5.77
1	5	SPV	10/22	38	2	6.00	7.50	5.50
1	5	All	----	38	----	6.00	7.50	5.50
3	5	SPV	11/4	37	3	7.67	8.00	3.00
3	5	Mag	11/4	37	4	6.00	6.00	4.50
3	5	Cov	11/6	39	4	5.75	6.50	5.25
3	5	All	----	38	----	6.47	6.83	4.25
All	5	All	----	38	----	6.24	7.17	4.88

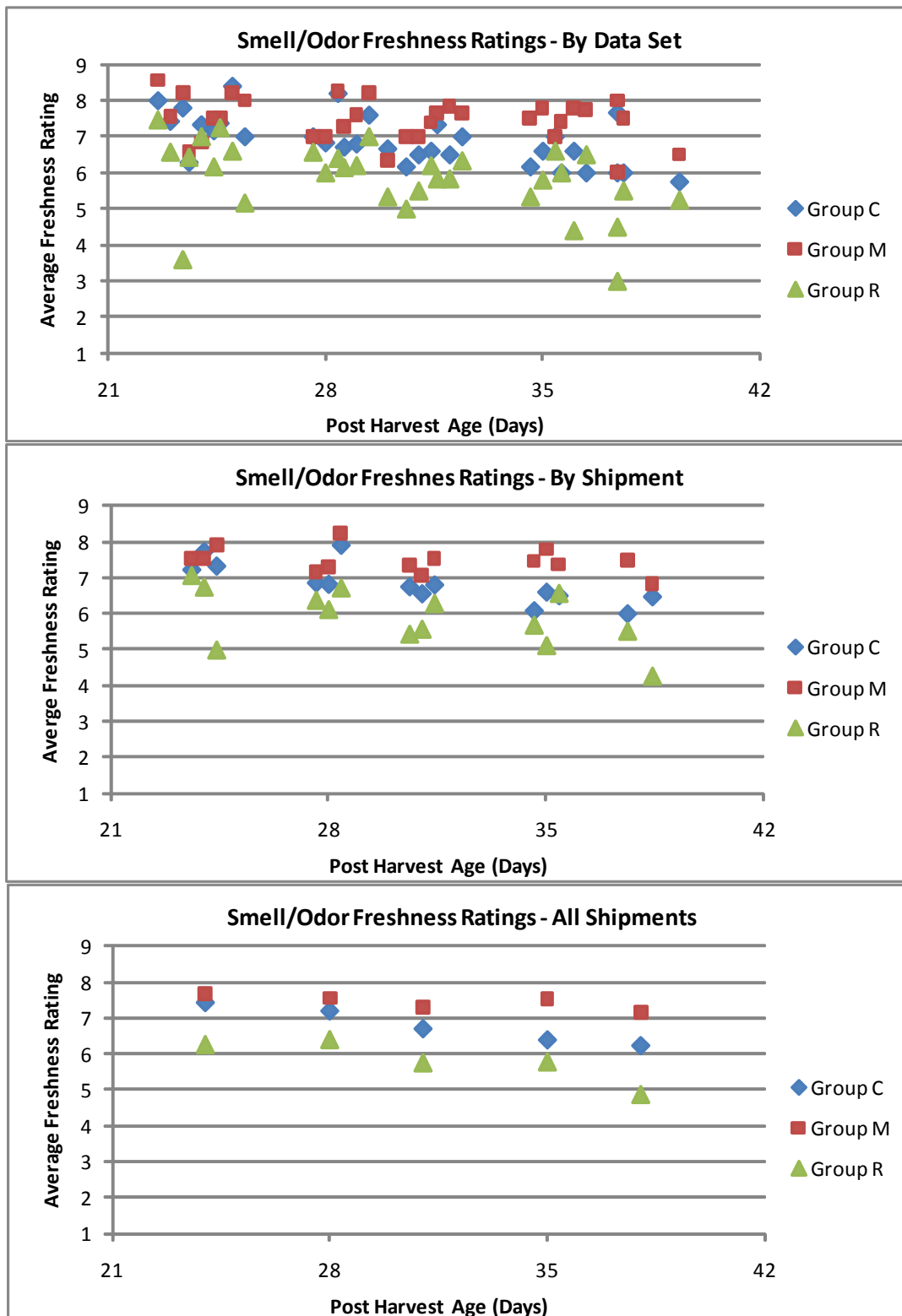


Figure C-11. DLA Broccoli Smell/Odor Freshness Ratings

Table C-12. DLA Broccoli Average Crispness/Firmness/Springback Freshness Ratings

Test Shipment	Age Group	Post Harv			No. Raters	Test Group		
		Facility	Date	Age		C	M	R
1	1	SPV	10/7	23	14	7.93	8.71	6.46
1	1	Mag	10/8	24	7	5.86	8.29	4.86
1	1	Cov	10/9	25	8	6.50	8.38	6.13
1	1	All	----	24	----	6.76	8.46	5.81
2	1	SPV	10/14	23	7	7.57	6.86	3.57
2	1	Mag	10/15	24	6	7.33	7.17	6.17
2	1	Cov	10/16	25	5	8.40	8.40	5.60
2	1	All	----	24	----	7.77	7.47	5.11
3	1	SPV	10/21	23	5	7.80	8.00	1.60
3	1	Mag	10/22	24	6	7.33	7.83	5.17
3	1	Cov	10/23	25	6	6.50	8.67	3.50
3	1	All	----	24	----	7.21	8.17	3.42
All	1	All	----	24	----	7.25	8.03	4.78
1	2	Mag	10/12	28	7	5.43	7.71	4.86
1	2	Cov	10/13	29	7	5.57	8.00	3.57
1	2	All	----	29	----	5.50	7.86	4.21
2	2	Mag	10/19	28	6	7.00	7.67	4.83
2	2	Cov	10/20	29	5	6.00	8.00	4.80
2	2	All	----	29	----	6.50	7.83	4.82
3	2	Mag	10/26	28	5	7.40	8.40	6.00
3	2	Cov	10/27	29	5	6.80	8.00	6.40
3	2	All	----	29	----	7.10	8.20	6.20
All	2	All	----	29	----	6.37	7.96	5.08
1	3	Mag	10/15	31	7	5.00	7.57	3.00
1	3	Cov	10/16	32	6	7.17	7.83	3.83
1	3	All	----	32	----	6.08	7.70	3.42
2	3	SPV	10/21	30	3	6.33	8.33	3.67
2	3	Mag	10/22	31	4	6.00	7.25	3.50
2	3	Cov	10/23	32	6	6.33	8.33	4.83
2	3	All	----	31	----	6.22	7.97	4.00
3	3	Mag	10/29	31	5	6.60	8.20	5.00
3	3	Cov	10/30	32	3	7.00	8.33	5.67
3	3	All	----	32	----	6.80	8.27	5.33
All	3	All	----	32	----	6.37	7.98	4.25

**Table C-12. DLA Broccoli Average Crispness/Firmness/Springback Freshness Ratings--
Continued**

Test Shipment	Age Group	Post Harv				No. Raters	Test Group		
		Facility	Date	Age	C		M	R	
1	4	Mag	10/19	35	6	6.00	8.00	5.00	
1	4	Cov	10/20	36	7	5.00	7.86	3.86	
1	4	All	----	36	----	5.50	7.93	4.43	
2	4	Mag	10/26	35	5	5.20	7.80	4.40	
2	4	Cov	10/27	36	5	5.80	8.40	3.60	
2	4	All	----	36	----	5.50	8.10	4.00	
3	4	Mag	11/2	35	5	6.20	6.80	6.20	
3	4	Cov	11/3	36	4	5.75	8.00	5.00	
3	4	All	----	36	----	5.98	7.40	5.60	
All	4	All	----	36	----	5.66	7.81	4.68	
1	5	SPV	10/22	38	2	5.50	8.00	5.00	
1	5	All	----	38	----	5.50	8.00	5.00	
3	5	SPV	11/4	37	3	6.67	8.67	1.33	
3	5	Mag	11/4	37	4	6.50	7.25	3.00	
3	5	Cov	11/6	39	4	7.00	8.25	3.25	
3	5	All	----	38	----	6.72	8.06	2.53	
All	5	All	----	38	----	6.11	8.03	3.76	

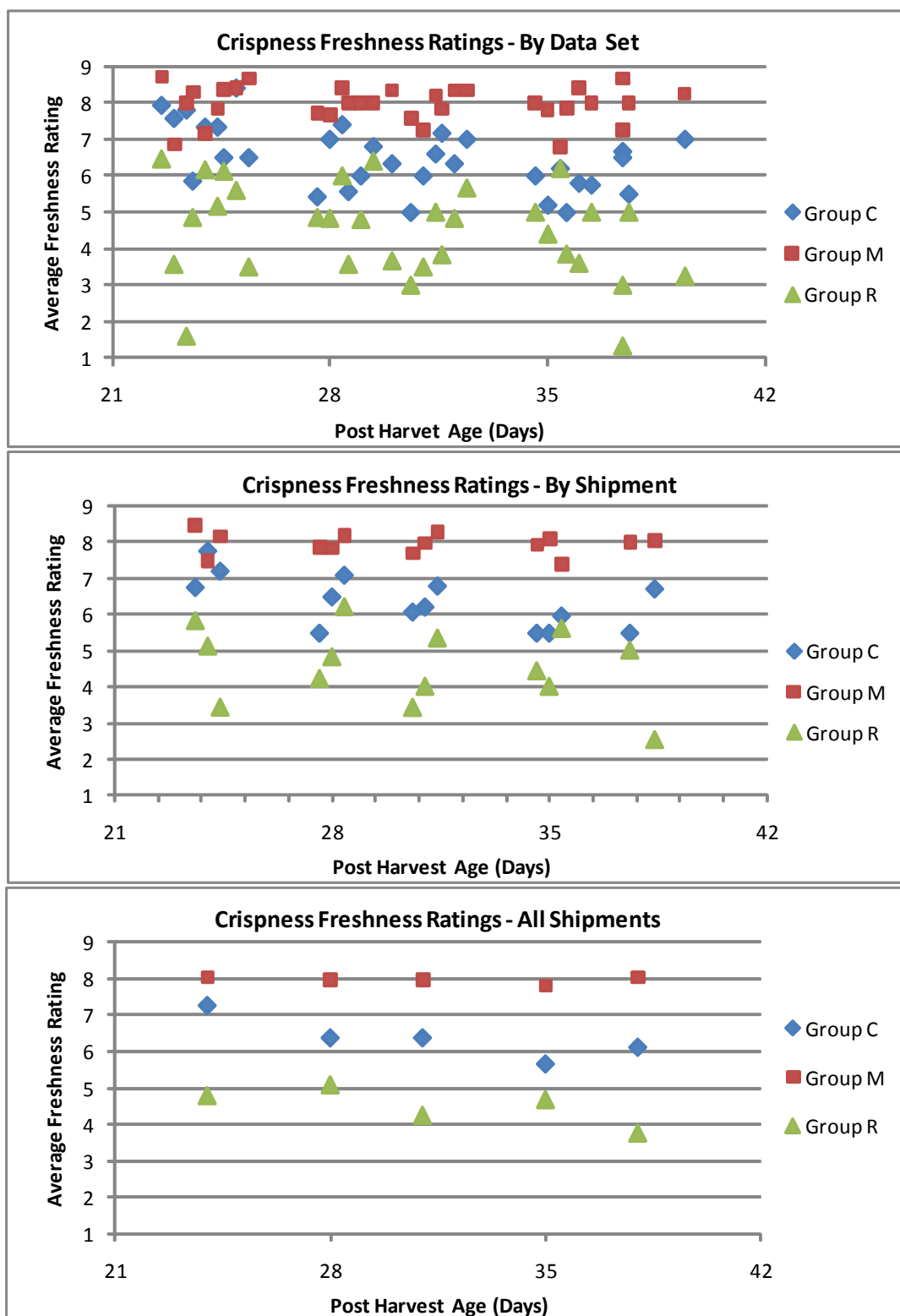


Figure C-12. DLA Broccoli Crispness/Firmness/Springback Freshness Ratings

Table C-13. Apio Broccoli Average External Appearance Freshness Ratings

Test Shipment	Age Group	No. Data Sets	Date	Raters/ Data Set	Post Harv Age	Test Group		
						Group C	Group M	Group R
2	1	1	10/14	7	23	8.29	8.00	7.57
2	2	2	10/19	3-3	28	7.83	8.50	7.50
2	3	1	10/21	3	31	8.00	8.33	7.00
2	4	1	10/26	2	35	7.00	6.00	4.00
2	5	1	10/28	4	38	6.00	8.25	7.00
3	1	1	10/21	5	23	8.40	8.00	7.40
3	2	1	10/26	2	28	7.50	7.50	7.00
3	3	1	10/28	4	31	7.00	7.75	7.50
3	4	3	11/1-11/2	3-5-4	35	5.76	5.37	6.09
3	5	4	11/3-11/5	3-3-4-4	38	5.08	3.75	5.21

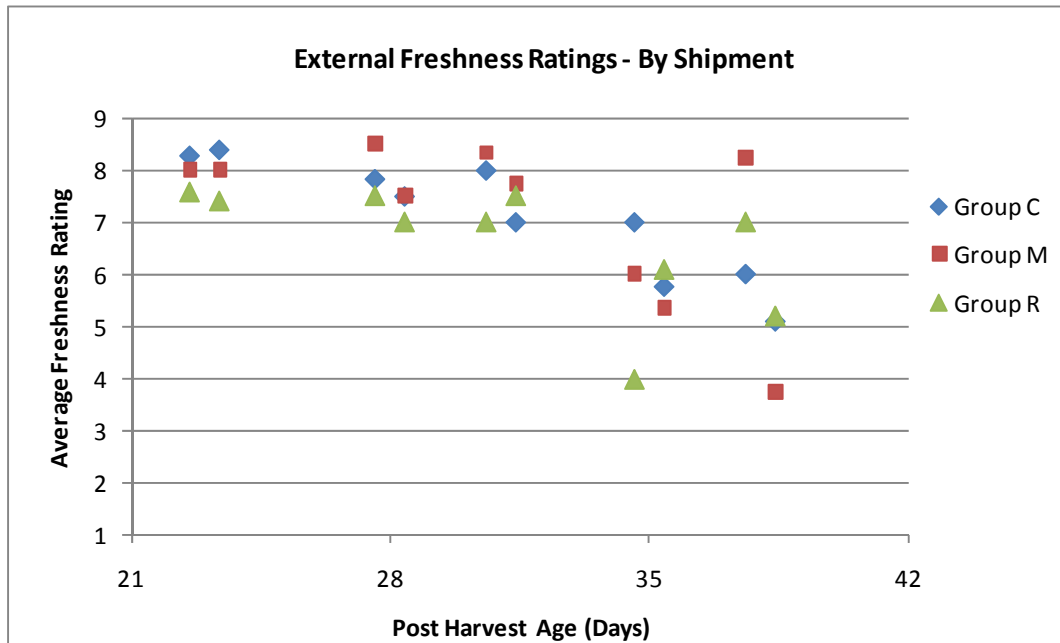


Figure C-13. Apio Broccoli External Appearance Freshness Ratings

Table C-14. Apio Broccoli Average Internal Appearance Freshness Ratings

Test Shipment	Age Group	No. Data Sets	Date	Raters/ Data Set	Post Harv Age	Test Group		
						Group C	Group M	Group R
2	1	1	10/14	7	23	7.71	8.14	7.86
2	2	2	10/19	3-3	28	7.33	8.00	6.33
2	3	1	10/21	3	31	7.67	8.33	6.00
2	4	1	10/26	2	35	6.50	7.50	4.00
2	5	1	10/28	4	38	5.25	8.00	6.00
3	1	1	10/21	5	23	8.00	6.00	7.00
3	2	1	10/26	2	28	5.00	7.50	5.00
3	3	1	10/28	4	31	7.25	7.75	7.50
3	4	3	11/1-11/2	3-5-4	35	6.02	6.41	5.61
3	5	4	11/3-11/5	3-4-3-4	38	5.44	4.98	5.42

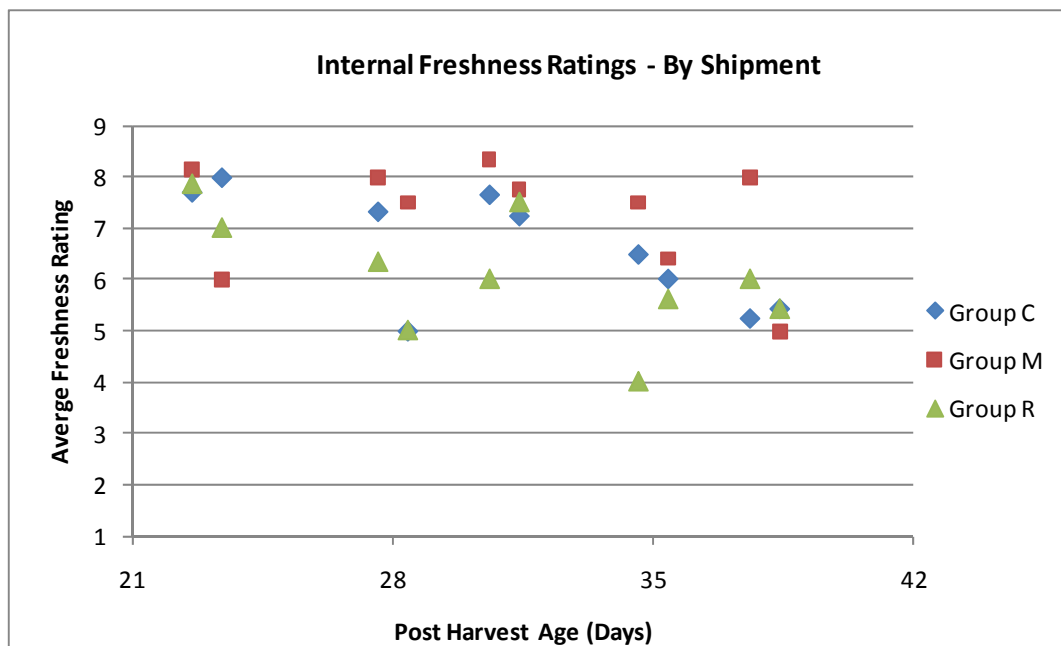


Figure C-14. Apio Broccoli Internal Appearance Freshness Ratings

Table C-15. Apio Broccoli Average Smell/Odor Freshness Ratings

Test Shipment	Age Group	No. Data Sets	Date	Raters/ Data Set	Post Harv Age	Test Group		
						Group C	Group M	Group R
2	1	1	10/14	7	23	7.71	7.71	7.43
2	2	2	10/19	3-3	28	7.17	8.00	6.33
2	3	1	10/21	3	31	7.33	7.67	6.33
2	4	1	10/26	2	35	6.00	7.00	4.00
2	5	1	10/28	4	38	5.25	7.75	6.00
3	1	1	10/21	5	23	7.80	7.80	7.60
3	2	1	10/26	2	28	7.50	7.50	7.50
3	3	1	10/28	4	31	7.25	7.75	7.50
3	4	3	11/1-11/2	3-5-4	35	6.49	6.73	6.36
3	5	4	11/3-11/5	3-4-3-4	38	5.85	5.67	5.71

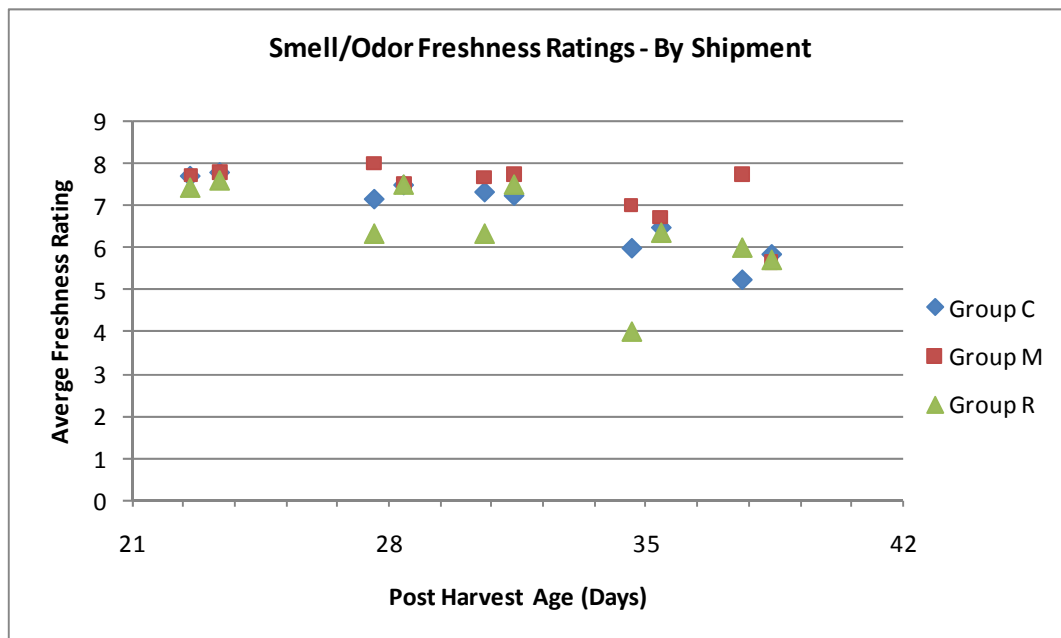


Figure C-15. Apio Broccoli Smell/Odor Freshness Ratings

Table C-16. Apio Broccoli Average Crispness/Firmness/Springback Freshness Ratings

Test Shipment	Age Group	No. Data Sets	Date	Raters/ Data Set	Post Harv Age	Test Group		
						Group C	Group M	Group R
2	1	1	10/14	7	23	8.29	7.71	6.71
2	2	2	10/19	3-3	28	7.33	8.50	5.17
2	3	1	10/21	3	31	7.00	8.33	5.00
2	4	1	10/26	2	35	4.00	7.50	3.00
2	5	1	10/28	4	38	4.75	8.25	4.75
3	1	1	10/21	5	23	8.60	8.40	6.80
3	2	1	10/26	2	28	7.50	7.50	7.00
3	3	1	10/28	4	31	7.75	8.00	8.00
3	4	3	11/1-11/2	3-5-4	35	6.23	7.46	5.59
3	5	4	11/3-11/5	3-4-3-4	38	6.00	6.90	6.33

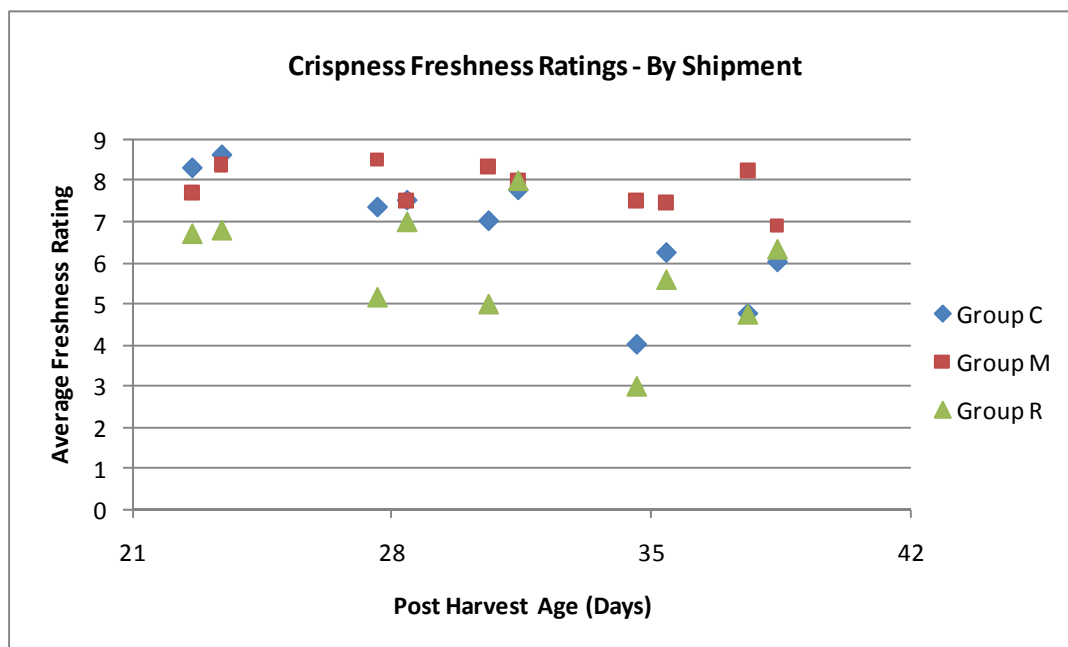


Figure C-16. Apio Broccoli Crispness/Firmness/Springback Freshness Ratings

Table C-17. Iceberg Lettuce Average Overall Freshness Ratings

Test Shipment	Age Group	Post Harv				Test Group		
		Facility	Date	Age	No Raters	C	M	R
1	1	SPV	10/7	23	14	6.55	6.27	4.91
1	1	Mag	10/8	24	7	6.57	6.29	6.43
1	1	Cov	10/9	25	8	6.00	7.00	6.67
1	1	All	----	24	----	6.37	6.52	6.00
2	1	SPV	10/14	23	7	7.86	7.86	7.43
2	1	Mag	10/15	24	6	7.86	7.57	7.43
2	1	Cov	10/16	25	5	7.75	6.50	8.00
2	1	All	----	24	----	7.82	7.31	7.62
3	1	SPV	10/21	23	5	8.00	8.00	8.00
3	1	Mag	10/22	24	6	6.83	7.33	7.00
3	1	Cov	10/23	25	6	8.00	7.60	7.60
3	1	All	----	24	----	7.61	7.64	7.53
All	1	All	----	24	----	7.27	7.16	7.05
1	2	Mag	10/12	28	7	3.71	3.86	4.25
1	2	Cov	10/13	29	7	5.13	5.00	6.13
1	2	All	----	29	----	4.42	4.43	5.19
2	2	Mag	10/19	28	6	6.83	7.00	7.17
2	2	Cov	10/20	29	5	7.00	5.60	6.80
2	2	All	----	29	----	6.92	6.30	6.98
3	2	Mag	10/26	28	5	6.80	6.80	6.00
3	2	Cov	10/27	29	5	7.00	5.80	5.80
3	2	All	----	29	----	6.90	6.30	5.90
All	2	All	----	29	----	6.08	5.68	6.02
1	3	Mag	10/15	31	7	4.00	4.00	4.43
1	3	Cov	10/16	32	6	4.00	4.17	5.00
1	3	All	----	32	----	4.00	4.08	4.71
2	3	SPV	10/21	30	3	7.25	7.25	6.75
2	3	Mag	10/22	31	4	6.00	6.50	5.75
2	3	Cov	10/23	32	6	6.80	4.80	7.00
2	3	All	----	31	----	6.68	6.18	6.50
3	3	Mag	10/29	31	5	5.80	5.20	
3	3	Cov	10/30	32	3	5.75	4.75	5.25
3	3	All	----	32	----	5.78	4.98	5.25
All	3	All	----	32	----	5.49	5.08	5.49

Table C-17. Iceberg Lettuce Average Overall Freshness Ratings—Continued

Test Shipment	Age Group	Post Harv				Test Group		
		Facility	Date	Age	No Raters	C	M	R
1	4	Mag	10/19	35	6	3.83	3.83	3.00
1	4	Cov	10/20	36	7	3.57	5.29	2.43
1	4	All	----	36	----	3.70	4.56	2.71
2	4	Mag	10/26	35	5	5.60	5.40	5.40
2	4	Cov	10/27	36	5	4.75	5.50	5.00
2	4	All	----	36	----	5.18	5.45	5.20
3	4	Mag	11/2	35	5	3.40	3.00	2.40
3	4	Cov	11/3	36	4	3.00	3.25	2.75
3	4	All	----	36	----	3.20	3.13	2.58
All	4	All	----	36	----	3.88	4.38	3.50
1	5	SPV	10/22	38	2	1.00	6.00	4.50
1	5	All	----	38	----	1.00	6.00	4.50
2	5	Mag	10/29	38	5	4.60	4.80	4.80
2	5	Cov	10/30	39	3	2.67	4.00	4.67
2	5	All	----	39	----	3.63	4.40	4.73
3	5	SPV	11/4	37	3	2.00	2.67	1.33
3	5	Mag	11/5	38	4	1.50	2.00	1.75
3	5	Cov	11/6	39	4	3.50	4.25	1.25
3	5	All	----	38	----	2.33	2.97	1.44
All	5	All	----	38	----	2.32	4.46	3.56

Table C-18. Romaine Lettuce Average Overall Freshness Ratings

Test Shipment	Age Group	Facility	Date	Age	No Raters	Test Group		
						C	M	R
1	1	SPV	10/7	23	14	7.90	8.00	7.90
1	1	Mag	10/8	24	7	6.57	7.14	5.86
1	1	Cov	10/9	25	8	7.25	7.25	6.00
1	1	All	----	24	----	7.24	7.46	6.59
2	1	SPV	10/14	23	7	7.86	7.57	7.57
2	1	Mag	10/15	24	6	7.13	7.38	7.25
2	1	Cov	10/16	25	5	8.20	8.40	8.20
2	1	All	----	24	----	7.73	7.78	7.67
3	1	SPV	10/21	23	5	8.20	8.80	7.80
3	1	Mag	10/22	24	6	7.83	7.83	7.83
3	1	Cov	10/23	25	6	8.25	8.50	7.75
3	1	All	----	24	----	8.09	8.38	7.79
All	1	All	----	24	----	7.69	7.87	7.35
1	2	Mag	10/12	28	7	6.14	7.14	6.57
1	2	Cov	10/13	29	7	7.13	6.88	6.50
1	2	All	----	28.5	----	6.63	7.01	6.54
2	2	Mag	10/19	28	6	7.33	7.50	6.50
2	2	Cov	10/20	29	5	4.60	7.00	6.60
2	2	All	----	28.5	----	5.97	7.25	6.55
3	2	Mag	10/26	28	5	7.00	8.00	7.00
3	2	Cov	10/27	29	5	7.20	7.40	6.60
3	2	All	----	28.5	----	7.10	7.70	6.80
All	2	All	----	28.5	----	6.57	7.32	6.63
1	3	Mag	10/15	31	7	4.57	6.86	3.86
1	3	Cov	10/16	32	6	5.60	5.80	5.00
1	3	All	----	31.5	----	5.09	6.33	4.43
2	3	SPV	10/21	30	3	6.75	7.00	6.50
2	3	Mag	10/22	31	4	5.75	7.25	6.50
2	3	Cov	10/23	32	6	4.00	7.20	6.60
2	3	All	----	31	----	5.50	7.15	6.53
3	3	Mag	10/29	31	5	6.00	7.40	5.40
3	3	Cov	10/30	32	3	6.75	7.00	6.25
3	3	All	----	31.5	----	6.38	7.20	5.83
All	3	All	----	31.5	----	5.65	6.89	5.60

Table C-18. Romaine Lettuce Average Overall Freshness Ratings–Continued

Test Shipment	Age Group	Facility	Date	Age	No. Raters	Test Group		
						C	M	R
1	4	Mag	10/19	35	6	5.33	6.50	5.33
1	4	Cov	10/20	36	7	5.71	5.29	1.00
1	4	All	----	35.5	----	5.52	5.89	3.17
2	4	Mag	10/26	35	5	3.40	6.00	5.60
2	4	Cov	10/27	36	5	4.80	7.00	4.80
2	4	All	----	35.5	----	4.10	6.50	5.20
3	4	Mag	11/2	35	5	5.40	6.00	3.40
3	4	Cov	11/3	36	4	6.75	7.00	6.50
3	4	All	----	35.5	----	6.08	6.50	4.95
All	4	All	----	35.5	----	5.23	6.30	4.44
1	5	SPV	10/22	38	2	5.50	6.00	2.00
1	5	All	----	38	----	5.50	6.00	2.00
2	5	Mag	10/29	38	5	4.00	6.20	4.00
2	5	Cov	10/30	39	3	4.33	6.00	4.00
2	5	All	----	38.5	----	4.17	6.10	4.00
3	5	SPV	11/4	37	3	6.67	6.67	5.67
3	5	Mag	11/5	38	4	3.25	3.75	3.50
3	5	Cov	11/6	39	4	4.75	6.75	3.00
3	5	All	----	38	----	4.89	5.72	4.06
All	5	All	----	38	----	4.85	5.94	3.35

Table C-19. DLA Broccoli Average Overall Freshness Ratings

Test Shipment	Age Group	Post Harv			No. Raters	Test Group		
		Facility	Date	Age		C	M	R
1	1	SPV	10/7	23	14	8.29	8.69	7.00
1	1	Mag	10/8	24	7	6.14	7.43	5.29
1	1	Cov	10/9	25	8	7.25	7.88	6.88
1	1	All	----	24	----	7.23	8.00	6.39
2	1	SPV	10/14	23	7	7.29	7.43	5.29
2	1	Mag	10/15	24	6	7.00	7.00	6.17
2	1	Cov	10/16	25	5	8.60	8.40	6.60
2	1	All	----	24	----	7.63	7.61	6.02
3	1	SPV	10/21	23	5	7.80	8.20	2.20
3	1	Mag	10/22	24	6	7.50	7.83	5.67
3	1	Cov	10/23	25	6	7.50	8.67	4.17
3	1	All	----	24	----	7.60	8.23	4.01
All	1	All	----	24	----	7.48	7.95	5.47
1	2	Mag	10/12	28	7	6.43	7.14	6.00
1	2	Cov	10/13	29	7	6.00	8.14	5.00
1	2	All	----	29	----	6.21	7.64	5.50
2	2	Mag	10/19	28	6	7.17	7.67	6.00
2	2	Cov	10/20	29	5	6.60	8.00	5.40
2	2	All	----	29	----	6.88	7.83	5.70
3	2	Mag	10/26	28	5	8.00	8.00	6.20
3	2	Cov	10/27	29	5	7.00	8.00	6.60
3	2	All	----	29	----	7.50	8.00	6.40
All	2	All	----	29	----	6.87	7.83	5.87
1	3	Mag	10/15	31	7	5.57	7.29	4.29
1	3	Cov	10/16	32	6	7.17	8.00	5.50
1	3	All	----	32	----	6.37	7.64	4.89
2	3	SPV	10/21	30	3	7.00	8.00	4.67
2	3	Mag	10/22	31	4	6.25	7.25	5.00
2	3	Cov	10/23	32	6	6.50	8.33	5.67
2	3	All	----	31	----	6.58	7.86	5.11
3	3	Mag	10/29	31	5	6.80	8.20	5.40
3	3	Cov	10/30	32	3	8.00	8.33	6.67
3	3	All	----	32	----	7.40	8.27	6.03
All	3	All	----	32	----	6.78	7.92	5.35

Table C-19. DLA Broccoli Average Overall Freshness Ratings--Continued

Test Shipment	Age Group	Post Harv				Test Group		
		Facility	Date	Age	No. Raters	C	M	R
1	4	Mag	10/19	35	6	6.00	7.83	5.33
1	4	Cov	10/20	36	7	5.14	7.71	5.00
1	4	All	----	36	----	5.57	7.77	5.17
2	4	Mag	10/26	35	5	6.20	7.80	5.00
2	4	Cov	10/27	36	5	6.60	8.20	3.80
2	4	All	----	36	----	6.40	8.00	4.40
3	4	Mag	11/2	35	5	6.80	6.80	6.60
3	4	Cov	11/3	36	4	6.00	8.00	6.00
3	4	All	----	36	----	6.40	7.40	6.30
All	4	All	----	36	----	6.12	7.72	5.29
1	5	SPV	10/22	38	2	6.00	8.00	5.00
1	5	All	----	38	----	6.00	8.00	5.00
3	5	SPV	11/4	37	3	7.00	8.33	1.67
3	5	Mag	11/4	37	4	6.25	6.75	3.50
3	5	Cov	11/6	39	4	6.50	7.25	4.50
3	5	All	----	38	----	6.58	7.44	3.22
All	5	All	----	38	----	6.29	7.72	4.11

Table C-20. Apio Broccoli Average Overall Freshness Ratings

Test Shipment	Age Group	No. Data Sets	Date	Raters/ Data Set	Post Harv Age	Test Group		
						Group C	Group M	Group R
2	1	1	10/14	7	23	8.14	8.00	7.43
2	2	2	10/19	3-3	28	7.17	8.33	6.17
2	3	1	10/21	3	31	7.67	8.33	6.33
2	4	1	10/26	2	35	6.00	7.50	4.00
2	5	1	10/28	4	38	5.25	8.00	6.25
3	1	1	10/21	5	23	8.20	8.00	7.00
3	2	1	10/26	2	28	7.50	7.50	7.00
3	3	1	10/28	4	31	7.50	7.75	7.75
3	4	3	11/1-11/2	3-5-4	35	6.42	6.57	6.08
3	5	4	11/3-11/5	3-4-3-4	38	5.63	5.06	5.60

Appendix D

MAPS Test Group Relative Overall Freshness Comparison Data Tables

This appendix provides the supporting data tables for each of the detailed graphs in Chapter 3 that compare overall relative freshness between test groups (M to C, M to R, and C to R), as follows:

Table D-1	Iceberg Lettuce - Group C and Group M
Table D-2	Iceberg Lettuce - Group M and Group R
Table D-3	Iceberg Lettuce - Group C and Group R
Table D-4	Romaine Lettuce - Group C and Group M
Table D-5	Romaine Lettuce - Group M and Group R
Table D-6	Romaine Lettuce - Group C and Group R
Table D-7	DLA Broccoli - Group C and Group M
Table D-8	DLA Broccoli - Group M and Group R
Table D-9	DLA Broccoli - Group C and Group R
Table D-10	Apio Broccoli - Group C and Group M
Table D-11	Apio Broccoli - Group M and Group R
Table D-12	Apio Broccoli - Group C and Group R

Table D-1. Iceberg Lettuce–Group C and Group M Average Relative Freshness Ratings

Test Shipment	Post Harvest Age	Test Group C Relative Freshness Rating by Data Set			Overall Average Relative Freshness Rating	
		SPV	Mag	Cov	Group C	Group M
1	23-25	0.00	-0.29	-1.38	-0.55	0.55
2	23-25	-0.43	0.57	1.75	0.63	-0.63
3	23-25	0.25	-0.67	0.80	0.13	-0.13
All	23-25	----	----	----	0.07	-0.07
1	28-29	----	0.00	0.50	0.25	-0.25
2	28-29	----	-0.50	1.80	0.65	-0.65
3	28-29	----	1.80	1.80	1.80	-1.80
All	28-29	----	----	----	0.90	-0.90
1	30-32	----	-0.14	0.00	-0.07	0.07
2	30-32	-2.00	-1.00	1.80	-0.40	0.40
3	30-32	----	0.40	1.00	0.70	-0.70
All	30-32	----	----	----	0.08	-0.08
1	35-36	----	0.40	-1.67	-0.63	0.63
2	35-36	----	0.80	-1.25	-0.23	0.23
3	35-36	----	0.20	-0.25	-0.03	0.03
All	35-36	----	----	----	-0.29	0.29
1	37-39	-2.00	----	----	-2.00	2.00
2	37-39	----	-0.40	-1.33	-0.87	0.87
3	37-39	-1.00	-0.50	-0.60	-0.70	0.70
All	37-39	----	----	----	-1.19	1.19

Table D-2. Iceberg Lettuce–Group M and Group R Average Relative Freshness Ratings

Test Shipment	Post Harvest Age	Test Group M Relative Freshness Rating by Data Set			Overall Average Relative Freshness Rating	
		SPV	Mag	Cov	Group M	Group R
1	23-25	1.18	-0.57	0.13	0.25	-0.25
2	23-25	1.00	0.43	-1.50	-0.02	0.02
3	23-25	-1.00	0.67	-0.40	-0.24	0.24
All	23-25	----	----	----	-0.01	0.01
1	28-29	----	-0.14	-1.75	-0.95	0.95
2	28-29	----	0.17	-1.20	-0.52	0.52
3	28-29	----	0.40	0.20	0.30	-0.30
All	28-29	----	----	----	-0.39	0.39
1	30-32	----	0.29	0.00	0.14	-0.14
2	30-32	1.50	1.25	-1.60	0.38	-0.38
3	30-32	----	----	0.50	0.50	-0.50
All	30-32	----	----	----	0.34	-0.34
1	35-36	----	1.60	1.67	1.63	-1.63
2	35-36	----	0.00	0.75	0.38	-0.38
3	35-36	----	0.60	0.25	0.43	-0.43
All	35-36	----	----	----	0.81	-0.81
1	37-39	1.50	----	----	1.50	-1.50
2	37-39	----	0.40	-0.33	0.03	-0.03
3	37-39	1.67	0.25	1.25	1.06	-1.06
All	37-39	----	----	----	0.86	-0.86

Table D-3. Iceberg Lettuce–Group M and Group R Average Relative Freshness Ratings

Test Shipment	Post Harvest Age	Test Group C Relative Freshness Rating by Data Set			Overall Average Relative Freshness Rating	
		SPV	Mag	Cov	Group C	Group R
1	23-25	1.91	0.14	-0.88	0.39	-0.39
2	23-25	0.86	1.14	-0.25	0.58	-0.58
3	23-25	-0.25	-0.17	1.60	0.39	-0.39
All	23-25	----	----	----	0.46	-0.46
1	28-29	----	-0.43	-1.63	-1.03	1.03
2	28-29	----	-0.33	1.00	0.33	-0.33
3	28-29	----	1.60	2.00	1.80	-1.80
All	28-29	----	----	----	0.37	-0.37
1	30-32	----	-0.29	0.00	-0.14	0.14
2	30-32	-1.50	0.50	0.80	-0.07	0.07
3	30-32	----	----	0.75	0.75	-0.75
All	30-32	----	----	----	0.18	-0.18
1	35-36	----	1.40	0.50	0.95	-0.95
2	35-36	----	0.80	-0.50	0.15	-0.15
3	35-36	----	0.80	0.00	0.40	-0.40
All	35-36	----	----	----	0.50	-0.50
1	37-39	-2.00	----	----	-2.00	2.00
2	37-39	----	-0.20	-1.00	-0.60	0.60
3	37-39	1.00	-0.25	0.75	0.50	-0.50
All	37-39	----	----	----	-0.70	0.70

Table D-4. Romaine Lettuce–Group C and Group M Average Relative Freshness Ratings

Test Shipment	Post Harvest Age	Test Group C Relative Freshness Rating by Data Set			Overall Average Relative Freshness Rating	
		SPV	Mag	Cov	Group C	Group M
1	23-25	0.10	-0.25	-0.20	-0.12	0.12
2	23-25	0.14	-0.86	-0.20	-0.30	0.30
3	23-25	-1.00	-0.67	-1.25	-0.97	0.97
All	23-25	----	----	----	-0.46	0.46
1	28-29	----	-1.57	0.86	-0.36	0.36
2	28-29	----	-0.60	-1.60	-1.10	1.10
3	28-29	----	-1.40	0.40	-0.50	0.50
All	28-29	----	----	----	-0.65	0.65
1	30-32	----	-2.33	0.80	-0.77	0.77
2	30-32	0.75	-1.25	-1.00	-0.50	0.50
3	30-32	----	-1.40	-1.75	-1.58	1.58
All	30-32	----	----	----	-0.95	0.95
1	35-36	----	-2.00	0.29	-0.86	0.86
2	35-36	----	-2.20	-3.00	-2.60	2.60
3	35-36	----	-1.60	-1.50	-1.55	1.55
All	35-36	----	----	----	-1.67	1.67
1	37-39	-2.00	----	----	-2.00	2.00
2	37-39	----	-2.00	-2.00	-2.00	2.00
3	37-39	-1.00	-0.75	-2.50	-1.42	1.42
All	37-39	----	----	----	-1.81	1.81

Table D-5. Romaine Lettuce–Group M and Group R Average Relative Freshness Ratings

Test Shipment	Post Harvest Age	Test Group M Relative Freshness Rating by Data Set			Overall Average Relative Freshness Rating	
		SPV	Mag	Cov	Group M	Group R
1	23-25	0.00	2.00	1.88	1.29	-1.29
2	23-25	0.29	0.57	1.40	0.75	-0.75
3	23-25	1.00	0.00	2.00	1.00	-1.00
All	23-25	----	----	----	1.01	-1.01
1	28-29	----	0.86	0.33	0.60	-0.60
2	28-29	----	1.60	0.60	1.10	-1.10
3	28-29	----	1.60	1.00	1.30	-1.30
All	28-29	----	----	----	1.00	-1.00
1	30-32	----	2.50	-0.80	0.85	-0.85
2	30-32	0.75	0.75	0.60	0.70	-0.70
3	30-32	----	2.00	1.75	1.88	-1.88
All	30-32	----	----	----	1.14	-1.14
1	35-36	----	1.60	2.43	2.01	-2.01
2	35-36	----	0.40	2.80	1.60	-1.60
3	35-36	----	2.20	2.25	2.23	-2.23
All	35-36	----	----	----	1.95	-1.95
1	37-39	2.50	----	----	2.50	-2.50
2	37-39	----	2.20	2.00	2.10	-2.10
3	37-39	2.33	0.25	2.25	1.61	-1.61
All	37-39	----	----	----	2.07	-2.07

Table D-6. Romaine Lettuce–Group C and Group R Average Relative Freshness Ratings

Test Shipment	Post Harvest Age	Test Group C Relative Freshness Rating by Data Set			Overall Average Relative Freshness Rating	
		SPV	Mag	Cov	Group C	Group R
1	23-25	0.30	1.50	1.88	1.23	-1.23
2	23-25	0.43	-0.29	1.40	0.51	-0.51
3	23-25	-0.25	0.17	1.00	0.31	-0.31
All	23-25	----	----	----	0.68	-0.68
1	28-29	----	-0.43	0.75	0.16	-0.16
2	28-29	----	0.80	-1.80	-0.50	0.50
3	28-29	----	0.20	1.20	0.70	-0.70
All	28-29	----	----	----	0.12	-0.12
1	30-32	----	0.50	1.00	0.75	-0.75
2	30-32	0.00	-1.00	-2.00	-1.00	1.00
3	30-32	----	0.40	1.50	0.95	-0.95
All	30-32	----	----	----	0.23	-0.23
1	35-36	----	0.20	2.29	1.24	-1.24
2	35-36	----	-2.00	-0.60	-1.30	1.30
3	35-36	----	1.20	1.00	1.10	-1.10
All	35-36	----	----	----	0.35	-0.35
1	37-39	2.00	----	----	2.00	-2.00
2	37-39	----	-0.20	1.00	0.40	-0.40
3	37-39	2.33	-0.25	1.50	1.19	-1.19
All	37-39	----	----	----	1.20	-1.20

Table D-7. DLA Broccoli–Group C and Group M Average Relative Freshness Ratings

Test Shipment	Post Harvest Age	Test Group C Relative Freshness Rating by Data Set			Overall Average Relative Freshness Rating	
		SPV	Mag	Cov	Group C	Group M
1	23-25	-1.15	-1.29	-1.13	-1.19	1.19
2	23-25	0.86	0.38	-0.20	0.34	-0.34
3	23-25	-0.80	-1.17	-2.40	-1.46	1.46
All	23-25	---	---	---	-0.77	0.77
1	28-29	---	-1.14	-2.00	-1.57	1.57
2	28-29	---	-1.00	-2.50	-1.75	1.75
3	28-29	---	-2.00	-2.40	-2.20	2.20
All	28-29	---	---	---	-1.84	1.84
1	30-32	---	-1.83	-1.20	-1.52	1.52
2	30-32	-1.67	-1.50	-2.33	-1.83	1.83
3	30-32	---	-2.00	-0.67	-1.33	1.33
All	30-32	---	---	---	-1.56	1.56
1	35-36	---	-1.00	-2.00	-1.50	1.50
2	35-36	---	-2.20	-2.50	-2.35	2.35
3	35-36	---	-0.60	-2.50	-1.55	1.55
All	35-36	---	---	---	-1.80	1.80
1	37-39	-2.50	---	---	-2.50	2.50
2	37-39	---	---	---	---	---
3	37-39	-0.33	-1.75	-2.00	-1.36	1.36
All	37-39	---	---	---	-1.93	1.93

Table D-8. DLA Broccoli–Group M and Group R Average Relative Freshness Ratings

Test Shipment	Post Harvest Age	Test Group M Relative Freshness Rating by Data Set			Overall Average Relative Freshness Rating	
		SPV	Mag	Cov	Group M	Group R
1	23-25	2.43	2.00	2.13	2.18	-2.18
2	23-25	2.29	0.75	3.00	2.01	-2.01
3	23-25	2.80	2.00	3.00	2.60	-2.60
All	23-25	---	---	---	2.27	-2.27
1	28-29	---	2.00	2.71	2.36	-2.36
2	28-29	---	2.17	2.50	2.33	-2.33
3	28-29	---	2.00	2.60	2.30	-2.30
All	28-29	---	---	---	2.33	-2.33
1	30-32	---	3.00	2.20	2.60	-2.60
2	30-32	2.67	2.25	2.50	2.47	-2.47
3	30-32	---	2.40	2.33	2.37	-2.37
All	30-32	---	---	---	2.48	-2.48
1	35-36	---	2.33	2.83	2.58	-2.58
2	35-36	---	2.40	2.75	2.58	-2.58
3	35-36	---	0.80	2.50	1.65	-1.65
All	35-36	---	---	---	2.27	-2.27
1	37-39	3.00	---	---	3.00	-3.00
2	37-39	---	---	---	---	---
3	37-39	3.00	2.25	2.50	2.58	-2.58
All	37-39	---	---	---	2.79	-2.79

Table D-9. DLA Broccoli–Group C and Group R Average Relative Freshness Ratings

Test Shipment	Post Harvest Age	Test Group C Relative Freshness Rating by Data Set			Overall Average Relative Freshness Rating	
		SPV	Mag	Cov	Group C	Group R
1	23-25	1.64	1.00	0.75	1.13	-1.13
2	23-25	2.14	0.63	2.80	1.86	-1.86
3	23-25	2.80	1.50	1.80	2.03	-2.03
All	23-25	---	---	---	1.67	-1.67
1	28-29	---	1.00	1.43	1.21	-1.21
2	28-29	---	1.00	0.50	0.75	-0.75
3	28-29	---	1.60	1.00	1.30	-1.30
All	28-29	---	---	---	1.09	-1.09
1	30-32	---	1.50	2.60	2.05	-2.05
2	30-32	1.67	1.50	0.33	1.17	-1.17
3	30-32	---	0.80	2.00	1.40	-1.40
All	30-32	---	---	---	1.54	-1.54
1	35-36	---	0.67	0.67	0.67	-0.67
2	35-36	---	1.00	1.00	1.00	-1.00
3	35-36	---	1.00	0.25	0.63	-0.63
All	35-36	---	---	---	0.76	-0.76
1	37-39	2.00	---	---	2.00	-2.00
2	37-39	---	---	---	---	---
3	37-39	2.33	1.75	2.00	2.03	-2.03
All	37-39	---	---	---	2.01	-2.01

Table D-10. Apio Broccoli–Group C and Group M Average Relative Freshness Ratings

Test Shipment	Post Harvest Age	Test Group C Relative Freshness Rating by Data Set			Overall Average Relative Freshness Rating	
		SPV	Mag	Cov	Group C	Group M
2	23	-0.43	---	---	-0.43	0.43
3	23	0.50	---	---	0.50	-0.50
All	23	---	---	---	0.04	-0.04
2	28	-2.33	-0.33	---	-1.33	1.33
3	28	-1.50	---	---	-1.50	1.50
All	28	---	---	---	-1.42	1.42
2	30	-1.67	---	---	-1.67	1.67
3	30	0.75	---	---	0.75	-0.75
All	30	---	---	---	-0.46	0.46
2	35	-2.00	---	---	-2.00	2.00
3	35-36	-1.33	0.60	-2.25	-0.99	0.99
All	35	---	---	---	-1.50	1.50
2	37	-2.25	---	---	-2.25	2.25
3	37-38	1.67	0.75	1.33	1.25	-1.25

Table D-11. Apio Broccoli–Group M and Group R Average Relative Freshness Ratings

Test Shipment	Post Harvest Age	Test Group M Relative Freshness Rating by Data Set			Overall Average Relative Freshness Rating	
		SPV	Mag	Cov	Group M	Group R
2	23	1.00	---	---	1.00	-1.00
3	23	1.75	---	---	1.75	-1.75
All	23	---	---	---	1.38	-1.38
2	28	2.00	2.00	---	2.00	-2.00
3	28	2.00	---	---	2.00	-2.00
All	28	---	---	---	2.00	-2.00
2	30	2.33	---	---	2.33	-2.33
3	30	1.50	---	---	1.50	-1.50
All	30	---	---	---	1.92	-1.92
2	35	2.00	---	---	2.00	-2.00
3	35-36	0.00	-0.20	2.25	0.68	-0.68
All	35	---	---	---	1.34	-1.34
2	37	2.50	---	---	2.50	-2.50
3	37-38	-2.67	-0.25	0.00	-0.97	0.97

Table D-12. Apio Broccoli–Group C and Group R Average Relative Freshness Ratings

Test Shipment	Post Harvest Age	Test Group C Relative Freshness Rating by Data Set			Overall Average Relative Freshness Rating	
		SPV	Mag	Cov	Group C	Group R
2	23	0.86	---	---	0.86	-0.86
3	23	1.75	---	---	1.75	-1.75
All	23	---	---	---	1.30	-1.30
2	28	1.67	2.00	---	1.83	-1.83
3	28	2.00	---	---	2.00	-2.00
All	28	---	---	---	1.92	-1.92
2	30	1.67	---	---	1.67	-1.67
3	30	0.75	---	---	0.75	-0.75
All	30	---	---	---	1.21	-1.21
2	35	1.50	---	---	1.50	-1.50
3	35-36	-0.67	1.00	-0.25	0.03	-0.03
All	35	---	---	---	0.76	-0.76
2	37	-0.50	---	---	-0.50	0.50
3	37-38	-2.00	0.75	1.67	0.14	-0.14